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GALATHEA REPORT

Volume 5

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Scientific Results
of The Danish Deep-Sea Expedition
Round the World 1950-52

ISSUED BY THE GALATHEA COMMITTEE
PRESIDENT: H.R.H. PRINCE AXEL OF DENMARK

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Deputy Leader of the Expedition

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SOME OBSERVATIONS ON *PELAGOSPHAERA* LARVAE

(Sipunculoidea)

By BERTIL ÅKESSON
Zoological Institute University of Lund

INTRODUCTION

In the material of the "Galathea" Expedition there are some specimens of the pelagical sipunculid larvae, the type of which was originally described by Mingazzini (1905) under the name of *Pelagosphaera aloysii*. The Committee and Prof. K. G. Wingstrand have been so kind as to place four specimens at the disposal of the present writer. The technical work has been supported by grants from the Swedish Natural Science Research Council.

The larvae were collected epipelagically off Natal (Feb. 17, 1951): St. 200, Lat. 29°39'S, Long. 37°01'E. Depth to bottom: 5020 m.

Mingazzini's description of *Pelagosphaera aloysii*, which he erroneously considered an adult sipunculid, was soon followed by others. Senna (1906) described some similar larvae which were collected during the same plankton expedition, the circumnavigation of the globe by the Italian ship "Liguria". In his detailed description, which was also based on sectioned material, Senna corrected the erroneous assumption that these pelagical sipunculids are adults. Independently of Senna's paper Spengel (1907) showed that *Pelagosphaera* must be a pelagical larva, probably belonging to the genus *Sipunculus*. He had no new material but compared Mingazzini's description and figures with the larva of *Sipunculus nudus*, which was well known to him and described in papers by Müller (1850), Krohn (1851), Keferstein & Ehlers (1861) and Hatschek (1884).

Heath (1910) observed two specimens, which were described both in living condition and after fixation also to some extent regarding their histological structures. Dawydoff (1930) made some interesting observations on living specimens which differed in several details from those described in previous papers.

After Dawydoff *Pelagosphaera* larvae have been recorded by Stephen (1941) and Fisher (1947). In *table 1* is given a survey of the different reports dealing with *Pelagosphaera* larvae. It is obvious that the larvae are neither restricted to the surface layers nor to the deeper layers. They have been collected both near the coast and in the open sea and are widely distributed in the oceans of the world. All the larvae are described to be spherical or somewhat elongated. The size varies between 0.5 and 6 mm. The more elongated larvae of *Sipunculus nudus* measure only about 0.3 mm. As will be seen in the following, the descriptions in the papers mentioned above indicate that all these recorded larvae do not belong to a single species. In fact there is no reason to presume all of them to belong to the genus *Sipunculus*.

Table 1.

Described by	Year of publ.	Locality	Depth	Size mm	Number of larvae
Mingazzini, P.	1905	Between New Zealand and New Caledonia	0-500 m	6	1
Senna, A.	1906	In Indonesian and Ceylonese waters	50-400 m	1.8-3.2	3
Heath, H.	1910	Monterey bay, Calif.	surface	2.5-3.2	2
Dawydoff, C. N.	1930	Off the coast of Annam	surface	0.5-1.5	> 30
Stephen, A. C.	1941	Off southeast Africa	300-1200 m	5	1
Fisher, W. K.	1947	Between Bermuda and the coast of Florida	0-150	3-6	many
Åkesson, B.	1961	Off Natal	0-5020 m	8-10	4

MORPHOLOGY

Only four specimens are available for the present study. They all have the introvert withdrawn. They are spherical or slightly ellipsoidal with the main axis from the mouth of the withdrawn introvert to the end of the ventral nerve cord. During the preservation the body wall has been deformed in some regions, (Pl. I, Fig. 1) but this is easily repaired if some of the preservation fluid is injected into the body cavity. The larvae have a remarkable size varying from 9.8 by 7.8 mm. to 10.5 by 8.2 mm. Even when stored in 70 % alcohol they are nearly transparent. They are all in the same stage of development.

The body wall is covered by an iridescent cuticula secreted from the underlaying epidermal layer and of about equal thickness, 5 μ. Numerous small pores belonging to the epidermal organs are irregularly scattered over the surface. These pores are extremely narrow and not elevated over the surface on papillae as in most sipunculids. The body wall musculature is thin, as could be expected in such a transparent pelagical larva. It consists of the outer circular and inner longitudinal layers. The connective tissue, dermis, which is normally found between the circular muscle layer and the epidermis, is practically absent. The longitudinal muscle layer is divided into 36 separate bundles, but this division is very insignificant. In sections the layer has the form of a continuous stratum.

There are three pairs of main retractors, two dorsal pairs and a ventral one. One of the two dorsal pairs extends from about the equatorial plane to the dorso-lateral part of the cephalic region. The other dorsal retractor pair extends from about 1.4 mm more anterior on the body wall at the same distance from the median plane and inserts laterally in the cephalic region. The ventral retractor pair extends from the equatorial plane of the body wall to the ventral part of the cephalic region. In addition to the retractor muscles there are also a number of delicate muscular strands extending from the body wall to the cephalic region and also to the intestine. The most conspicuous of these strands is a ventral pair which may possibly be interpreted as a second pair of ventral retractor muscles.

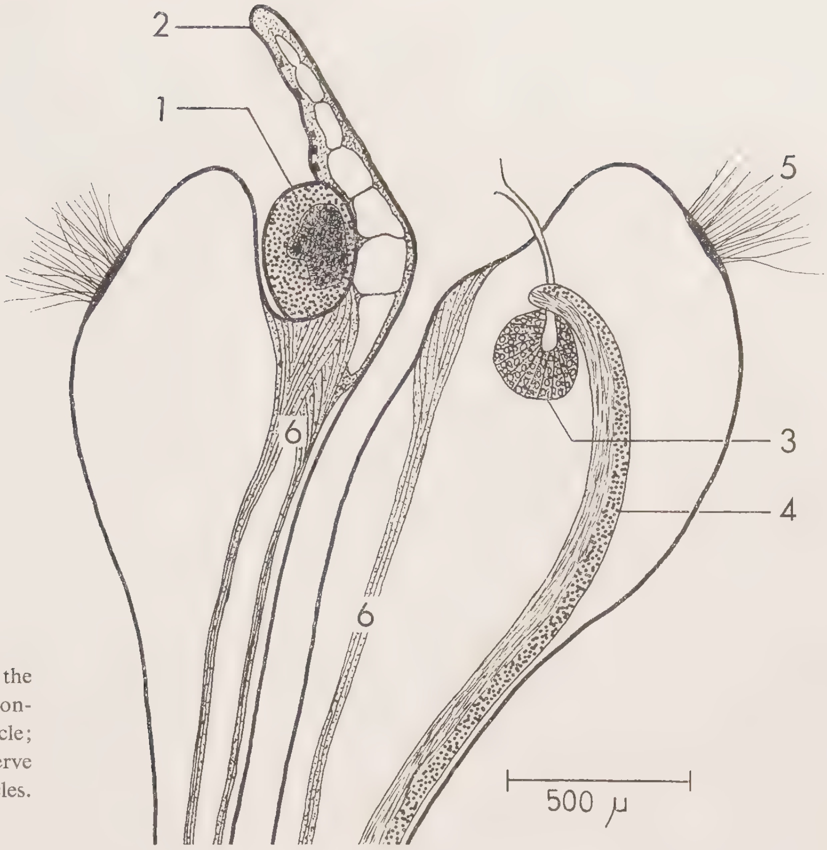
The most interesting part of these larvae is the inverted cephalic region with its appendages. All the specimens examined have the introvert withdrawn, but it is relatively easy to imagine the position of the structures in an extended condition. Such a reconstruction of an extended head of a *Pelagosphaera* larva is seen drawn in Text-figure 1. The mouth has the form of a wide funnel, which narrows to form the oesophagus. The ciliated epithelium of the dorsal part of the mouth continues in the epithelium of a single, conspicuous tentacular fold. This fold is divided into two parts by a median furrow. The brain is situated at the base of the aboral side of the tentacular fold.

In sagittal sections the brain seems to be somewhat compressed in a dorso-ventral direction, but possibly this is only a result of the inverted condition. The dorsal surface of the brain forms a continuation of the surrounding epidermal layer.

The circumoesophageal connectives fuse and form the ventral nerve cord, which is free from the body wall in the anterior part and attached by long lateral nerves. It is followed by two insignificant paraneural muscles. The nerve cord ends in the region of a terminal organ. Ventral to the oesophagus, connected with the anterior end of the nerve cord, there is a glandular organ, which consists of two hemispherical lobes whose cavities fuse into a common duct. The duct is attached to the nerve cord and the connectives. In the distal part it is also attached to the ventral wall of the oral disc. The most distal part of the duct projects into the funnel-like cavity of the mouth. In this part it is covered by the ciliated columnar epithelium cells of the oral disc. The mouth of the duct is somewhat distended and divided into two lateral laps.

The tentacular fold contains cavities belonging to the polian systen. The cavities form a system of intercommunicating channels separated by strands of connective tissue. This tentacular system communicates with a subcerebral chamber and a vessel along the dorsal part of the oesophagus. There is, however, no trace of the circular vessel round the beginning of the oesophagus, which is found in most sipunculids.

The digestive tract forms a simple loop. It is much shorter than in other sipunculid larvae and has no tendency to form a coil. The first part, the oesophagus, is relatively narrow. It is followed by a sac-like evagination, the stomach according to HEATH's terminology. This part narrows to form the intestine, which is followed by the very short proctodaeal rectum. This opens in the body wall somewhat anterior to the attachment of the shortest dorsal retractor pair.



Text-fig. 1. A scheme of the head of the *Pelagosphaera* larva in an extended condition. 1, cerebral ganglion; 2, tentacle; 3, glandular organ; 4, ventral nerve cord; 5, metatroch; 6, retractor muscles.

The two nephridia have a lateral or slightly ventro-lateral position at the level of the anus. The size is about 0.9 by 0.5 mm. The nephrostome and the nephridiopore are close together separated only by a membrane which reaches about four-fifths of the distance to the free end of the nephridium.

In the coelomic fluid are found red corpuscles, amoebocytes and giant multinucleated bodies. The first two types are also found in the polian system.

COMPARISONS

As most of the older reports deal only with the morphology in broad outline, it may be convenient now to make a comparison between them and the description given above.

From the *table 1* is seen that the animals from the "Galathea" expedition are larger than any of the others. However, the larval characters of the "Galathea" animals are beyond doubt. There are no traces of gonads.

It is obvious that all larvae described in this and previous papers are sipunculid larvae. Nothing else is suggested except by Heath, who points out certain similarities with the Echiurid larvae, especially those of *Echiurus pallasii*. However, this mistake depends on the fact that he is not clear about the morphology of the larvae under normal condition, i.e., when the introvert is extended. What Heath considers as the mouth is nothing but the opening on the boundary between the trunk and the invaginated introvert. What is described as a conspicuous dorsal sac of the pharynx is the part of the head dorsal to the tentacular fold. Also Senna mentions the dorsal sac. According to Heath all six retractors are attached to this region. This condition has not been seen by others, and it is impossible to evaluate this statement. Also with respect to the ciliation these larvae differ from those described in other papers, i.e., when any ciliation is mentioned at all. Only from the dorsal diverticulum are cilia mentioned and no cilia are found ventral to the mouth. The larvae of Senna and Dawydoff have a metatroch like the "Galathea" larvae. In the other papers nothing is said about ciliation.

For the taxonomic account of the sipunculids the number and arrangement of the retractor muscles have a great significance. In the larvae described by MINGAZZINI, SENNA and HEATH the retractor number is 6, but FISHER mentions 4 retractors and 8 delicate strands. FISHER's statement agrees fairly well with the condition in the larvae of *Sipunculus nudus* (HATSCHEK 1883). These larvae have 4 retractors and, at least during the first pelagic stage, another 4 accessory retractors, which disappear in the beginning of the metamorphosis. These accessory retractors are very delicate structures as compared with the persistent ones.

Another thing of taxonomic value is the arrangement of the muscle layers of the body wall. Judging from the descriptions and especially from the pictures all the larvae have the longitudinal muscle layer separated into bundles, although the separation is indistinct in some of them. The "Galathea" larvae have 36 bundles like the larva described by STEPHEN. Those described by FISHER all have 56 bundles except one which has a brown and opaque body wall and not over 15 muscle bundles. This single specimen is suggested to belong to a different species. For comparison it ought to be mentioned that the *Sipunculus nudus* larvae like the adult animals have 32 longitudinal muscle bundles (HATSCHEK l.c.).

With respect to the body wall DAWYDOFF's observations are very interesting. Instead of the insignificant papillae, irregularly scattered over the surface, which are reported from the other larvae, these have prominent papillae arranged in longitudinal rows on the trunk. In connection with the metamorphosis the epidermal organs, which open on the papillae, secrete an envelope in the shelter of which the metamorphosis occurs.

DAWYDOFF states that his larvae have protonephridia in addition to metanephridia of the normal sipunculid type. However, as the present writer has tried to show in an earlier paper (ÅKESSON 1958, pp. 68-69) he has probably mistaken the ventral glandular organ for the protonephridia.

As can be seen from the foregoing, it is most probable that the larvae described in this and previous papers represent a number of different species. Larvae in the same stage of development with 15, 36 and 56 longitudinal muscle bundles cannot belong to the same species. When also the number of retractor muscles and the arrangement of the epidermal papillae are considered, it is obvious that they represent at least 4, perhaps 5 different species. The possible relations between the larvae and the hitherto known adult sipunculids will be discussed after the description of the histological structures.

HISTOLOGY

The Body Wall

The morphology of the body wall has been dealt with above. With respect to the histology the epidermal organs are of the most interest. They are of two types which closely resemble two of the three types found in the genus *Sipunculus*. (METALNIKOFF 1900; ÅKESSON l.c.). The most conspicuous type is the bicellular glandular organ. This consists of two bulb-shaped cells pressed together. In the distal part of each cell there is a small receptacle. The two receptacles open with a common, very narrow duct through the cuticula. Each gland cell has two nuclei, one in the distal part and one in the proximal part. The whole organ is approximately spherical with a diameter of 25-40 μ.

The other epidermal organ type is much smaller, an elongated mass of sensory cells with a size of 10 by 20 μ. This organ type is always connected with the bicellular glandular one. They have a position close to the delicate connective sheath which surrounds the first organ type and open on the surface only 7-8 μ from the glandular duct.

The Cerebral Ganglion

The cerebral ganglion shows an internal structure very similar to that of the ganglion of *Sipunculus nudus*. In order to understand the special conditions in the *Pelagosphaera* ganglion, it is necessary, however, to give a short survey of the relations between the cerebral ganglion and the surrounding tissues in sipunculids.

In most sipunculids the cerebral ganglion is elongated along the transversal axis. In the early trochophora the apical plate is terminal. Later it is moved to a more dorsal position. A comparative study of the later development (ÅKESSON 1958, fig. 77) indicates that this includes turnings around the transversal axis. All sipunculid species retain the epithelial position of the cerebral ganglion. In the adults of all species except *Onchnesoma steenstrupi* it is the anterior margin of the ganglion which retains the connection with the surrounding ectoderm. This part of the ganglion forms a special organ, the cerebral organ. The function of the organ is not known. In larval stages it has a strong secretory activity. It is nonciliated and in the adults always covered by a thick cuticula.

In *Pelagosphaera* the turning of the cerebral ganglion has only reached a stage corresponding to that of a *Sipunculus nudus* larva in the first beginning of the metamorphosis. The free, epithelial part has a dorsal position and forms the whole flattened dorsal surface of the ganglion. Perhaps it is not quite correct to describe the position of the ganglion so in detail when all the larvae studied have the introvert withdrawn, but as a matter of fact the movements of the introvert in sipunculids will not change the relative position of the cerebral ganglion.

The oesophageal connectives enter the cerebral ganglion ventrally at some distance from the lateral margin. Within the ganglion they continue in the central neuropile mass. They are also connected with a posterior ventral commisure and with a posterior dorsal commisure. These two posterior commissures are homologous with the posterior dorsal commissure and the anterior dorsal commissure respectively in the brain of *Sipunculus nudus* (Åkesson l.c., pp. 122 ff.).

In close connection with the oesophageal roots two pairs of nerves are given off. The strongest one is given off from the most lateral part of the ganglion. It innervates the body wall in the head region. The other nerve pair innervates the ventral side of the tentacular fold. From this pair is also given off nerve branches to the dorsal and lateral parts of the oral disc. Together with other small branches from the connectives they form the origin of the intestinal plexus. From the dorso-lateral part of the ganglion another pair of strong tentacular nerves is given off without any connection with the connectives.

Three types of ganglion cells can be observed in the cerebral ganglion. The first type, which includes the majority of the cells, is very small, poor in cytoplasm and obviously unipolar. The diameter of the rounded nucleus is 5 μ. There is a certain concentration of this type in the lateral part of the ganglion, corresponding to the position of the globuli in the genus *Sipunculus*. However, the aggregated cells are impossible to distinguish from other small ganglion cells.

The other type is richer in cytoplasm and has a length of 15-18 μ. The slightly elongated nucleus has a length of 7-8 μ. This type is most frequent along the anterior margin of the ganglion.

In the posteroventral part of the ganglion we can find the third type, giant cells with a length of 30-35 μ and a large nucleus, 12-14 μ, rich in chromatin.

All these three cell types correspond to cell types found in the cerebral ganglion of members belonging to the genus *Sipunculus*. In fact, all structures in the brain of *Pelagosphaera* are to be compared with structures in the brain of this genus.

In the most lateral part of the cerebral ganglion two rudimentary ocular tubes can be found. They are insignificant infoldings covered by a thickened cuticula. The cells round the infoldings are somewhat pigmented. It is only from the comparative study of other sipunculids that it is possible to localize these eye rudiments.

Within the ganglion without any connection with the surrounding brain capsule another pair of photoreceptory organs is found. It consists of two cup-shaped pigmented aggregations of cells which have the concavity in a lateral direction. Obviously it is the inverse larval eyes corresponding to those pictured by Gerould (1907, fig. 90) from *Golfingia vulgare* and by Hatschek (figs. 69-73) from *Sipunculus nudus*. Also Senna pictures two types of eyes in his *Pelagosphaera* larvae.

The Tentacle

The tentacle forms a conspicuous transversal fold between the brain and the mouth (Pl. II, fig. 2). At the base the fold has a breadth of 1.1 mm, which is more than the breadth of the cerebral ganglion. The ciliated epithelium on the oral side consists of slender cylindrical cells with a length of about 30 μ. The strong basement membrane of this epithelium layer is covered on the other side with the flat epithelium cells of the tentacular cavities.

The aboral side of the tentacular fold is covered with a peculiar epithelium layer. On the surface it has secreted a cuticula. Cilia are lacking. The nuclei of the cells are situated near the surface together with most of the cytoplasm. From the proximal part of the cells slender fibrous strands transverse the wall to the basement membrance under the tentacular cavities. Together with connective fibers these strands form a meshwork which is filled with large acidophilic cells. This part seems to give the stability to the tentacular fold and probably it also forms a shelter for the exposed cerebral ganglion.

On the aboral side and especially on the lateral margins of the tentacular fold a special type of sensory organs is to be found. The organs have been described by the present writer under the name of "tentacular eyes" (Åkesson 1958 pp. 139 ff.). They have been found on three members of the genus *Sipunculus: S. nudus, S. angasi,* and *S. norvegicus.* They are not known from other sipunculid genera. In the *Pelagosphaera* larvae the organs do not give the same impression of photoreceptory organs as in the *Sipunculus* species owing to the fact that the pigmentation is lacking. A single organ has the form of a deep cylindrical depression, which is lined with ciliated cells (Pl. II, fig. 3). The cells of the surrounding surface are also ciliated. There is an increased number of cells around the proximal part of the depression. Some of these cells are supporting cells, but judging from the structure of the organ of the *Sipunculus* species, some are sensory cells. In these species there is also a strong pigmentation in both the epithelium cells and in the sensory cells. However, the principal structure is exactly the same in the *Pelagosphaera* larvae.

The Glandular Organ

The glandular organ which opens on the ventral median part of the oral disc is a typical larval organ, which has been described among others by HATSCHEK from the *Sipunculus nudus* larvae. In the *Pelagosphaera* larvae the organ is a large structure, the gland and the duct measure together about 1 mm (Text-fig. 1). The main part of the two hemispherical lobes of the proper gland consists of slender secretory cells with a length of about 110 μ. The surface of the gland is covered with a delicate sheet of connective tissue. The secretion shows in azan a basophilic staining reaction. The nuclei of the glandular cells are somewhat ellipsoidal, 8 by 5 μ. In the four specimens available for the histological study each glandular lobe is separated into two halves, the gland cells of which are in different phases of secretory activity.

The gland cells reach to a central cavity with a diameter of about 100 μ. As can be seen in fig. 6 (Pl. IV) the glandular cells only form the lining of two quadrants in a transversal section. The walls in the other two quadrants are ciliated. A closer study of the ciliated areas shows that each quadrant consists of a single arched cell. A number of such large ciliated cells forms two distinct areas in the median plane of the organ. They continue in the proximal part of the duct. In the rest of the duct the wall consists of a large number of ciliated cells. The most distal part of the duct projects over the surface of the oral disc and forms a narrow funnel, which is divided into two lobes by a median furrow.

HATSCHEK's opinion that the glandular organ arises as a stomodaeal evagination is supported by the fact that the ciliated cells are lined with a delicate cuticula.

In respect to the histological structures there is no close connection between the glandular organ and the central nervous system. The gland is situated dorsal to the most anterior part of the ventral nerve cord. It projects free into the coelom and is attached to the fork of the oesophageal connectives only by means of the duct. The duct passes between the connectives and the oesophagus wall, and the surrounding sheet of connective tissue is partly common with that of the connectives and the anterior part of the ventral nerve cord. No nerves have been observed passing from the connectives or nerve cord to the glandular organ.

In his papers about the development of the sipunculids GEROULD (1903 and 1907) has pointed out the similarities between the glandular organ and a similar organ in the heteropod *Firoloides* (FOL 1876). Both structures are stomodaeal evaginations which are more or less reduced in adult condition, but except for these similarities it seems difficult to get anything out of this comparison. Within the sipunculid group, however, there is another organ which deserves to be mentioned in this connection. In the genera *Aspidosiphon, Siphonosoma* and *Phascolosoma* (previously *Phymosoma* or *Physcosoma)* the most anterior part of the ventral cord is in close contact with a tubular organ which seems to be an epidermal invagination. (SPENGEL 1912, pp. 268 ff.; ÅKESSON 1958, pp. 107 ff.). The tube opens on the surface in the ventral median line immediately posterior to the cervical collar. In some species, for instance in *Phascolosoma granulatum,* the innermost part of the tube penetrates the connective tissue sheet of the nerve cord and forms within this an enlarged cavity. The cavity is filled with a solid body, which is probably derived from the cuticula of the tube. According to SPENGEL the organ must be interpreted as a statocyst. But in some species, for instance in *Siphonosoma cumanense* and *Aspidosiphon clavatus,* the organ has a somewhat different structure and cannot function as a statocyst.

When comparing the glandular organ of the *Sipunculus* and *Pelagosphaera* larvae with "the ventral sensory organ" in the genera mentioned above we will find striking similarities. Both organs have an ectodermal origin and have resulted from invaginations in the ventral median plane. Both are closely connected with the anterior end of the ventral nerve cord. As a matter of fact there is nothing speaking against an assumption that the organs are homologous. Unfortunately nothing is known about the development of the genera *Phascolosoma, Aspidosiphon* and *Siphonosoma.* These three genera form a distinct group among the sipunculids not only owing to the presence of the ventral sensory organ but also in having the same types of epidermal organs and the same arrangement of the lateral nerves of the ventral nerve cord. (Åkesson l.c., pp. 227ff). The different position of the external opening of the duct will not form any insuperable difficulty to explain. Among the sipunculids there are several examples of similar displacements. The retractor muscles can be attached with their posterior part in the first third of the trunk, in the second third or sometimes in the most posterior part of the trunk. The anus is usually situated between the first and second third of the trunk, but in the genus *Onchnesoma* the anus has a position just posterior to the head.

The Metatroch

It is quite obvious that a larva with the spherical form and the size of the *Pelagosphaera* must have some kind of floating apparatus for the pelagical mode of life. The body proper is covered with a cuticula, but around the "head" we find a prominent circlet of ciliated cells, a metatroch. As all the four animals studied have the introvert withdrawn, the metatroch is found in the cavity in which we also find the cerebral ganglion, the tentacle, the mouth and the duct of the glandular organ.

The cilia of the metatroch cells are extremely long, 170 μ. For comparison it ought to be mentioned that the cilia of the oral disc and the tentacle have a length of only 10 μ.

The metatroch cells form an about 85 μ broad continuous girdle around the head. They are slender cylindrical cells with a length of about 35 μ. Some of the cells seem to have begun to degenerate and have lost their nuclei.

In the margin of the metatroch girdle, both the anterior and posterior margin, there is a zone from which the ciliated cells probably are regenerated. The cells in this zone have big rounded nuclei with a diameter of 10-12 μ. The cells of the zone have no cilia. They show the same staining reaction as the metatroch cells. The boundary between the metatroch and the surrounding cells is not at all as sharp as in other sipunculids (Gerould 1907, Åkesson 1958).

It may be questioned whether the metatroch has not a second function in addition to acting as a floating organ. In the first part of the intestine of two of the animals is found a dense mass of long metatroch cilia mixed with small organisms, which could not be identified. It is not quite improbable that the cilia are sticky and that small planktonic organisms adhere to them and afterwards are swallowed together with the cilia.

The Ventral Nerve Cord

The ventral nerve cord is of the ordinary sipunculid type, i.e., it is completely unpaired and without any trace of metamerism. In the introvert region and in the anterior part of the trunk region the nerve cord is accompanied by two paraneural muscles. These parts of the nerve cord are attached to the body wall by means of long lateral nerves. More posteriorly the cord is more closely attached to the body wall. The lateral nerves are surrounded by a strong connective sheath in which also muscle fibers are seen.

In most sipunculids the ventral half of the nerve cord is occupied by the nerve cells, the dorsal half by the neuropile. In the *Pelagosphaera* larvae, however, the nerve cells also occupy the lateral parts of the cord (Pl. III fig. 4).

Two types of cells can be distinguished. One of them, which is very poor in cytoplasm and has slightly elongated nuclei, has a lateral position. The other type is situated in the median plane completely separating the members of the first type into two lateral parts. These cells have more cytoplasm and rounded nuclei (Pl. III, figs. 4 and 5). However, the position of the two cell types gives no evidence of any paired origin of the nerve cord. From the study of the regeneration ability of sipunculids (Schleip 1934, 1935; Wegener 1938) it is known that the ventral nerve cord contains a strand of regeneration cells which often has a median position. The present writer has seen the same regeneration cells in several sipunculid species, especially markedly in *Onchnesoma steenstrupi* (Åkesson l.c. fig. 71). It is possible that the regeneration strand in all sipunculids is nothing but a strand of neuroblasts, which in larvae and juvenile animals successively forms new neurons and in an injured animal differentiates into the ectodermal part of the regenerate.

The Terminal Organ

The posterior end of the ventral nerve cord is closely connected to a strange organ, the terminal organ, which is only found in the genera, *Sipunculus* and *Xenosiphon*. The organ has been described by several authors; its histological structures in adult members of the genus *Sipunculus* by ANDREAE (1882), SPENGEL (1913) and ÅKESSON (1958). The organ is also reported from the *Sipunculus nudus* larva (HATSCHEK 1884). In the adult *Sipunculus* species the terminal organ forms a sac-like invagination in the posterior tip of the animal. The innermost parts of the sac are lined with a glandular stratified epithelium which is divided into a number of separate lobes. The gland cells of each lobe opens on a pore field. Probably each pore represents a single gland cell. The secretion of the cells form thread-like structures in the cavity of the sack. In their distal ends these threads dissolve and form a secretion which is given off to the surrounding water.

In the *Pelagosphaera* larvae the terminal organ has the same principal structure but is more simple. The cavity of the invagination is extremely narrow and lined with a thick cuticula. No pore fields have been observed and judging from the staining reaction the secretory activity has not begun. The stratified glandular epithelium is not separated into lobes but forms a sheath around the innermost parts of the cavity. The whole organ is approximately spherical with a diameter of about 200 μ.

Under normal conditions the organ probably is evaginated. The change between the everted and inverted position depends partly upon the coelomic pressure and partly upon the presence of two strong muscles. One of these, a typical retractor muscle, runs parallel to the nerve cord on the left side. It is attached to the inner surface of the terminal organ with the posterior end. The anterior end is successively flattened and transformed into the longitudinal muscle bundle just to the left of the nerve cord.

The function of the other muscle is more difficult to evaluate. It is a transversal muscle which is attached to the middle of the terminal organ perpendicular to the nerve cord. Also this muscle is derived from the longitudinal muscle layer. It is possible that this muscle takes part both in the inversion and the eversion of the organ.

At the posterior end the ventral nerve cord forks into two branches. One of these penetrates the retractor muscle parallel to the nerve cord. From this nerve the inner part of the organ is innervated. The other nerve branch innervates the transversal muscle and the middle and distal part of the terminal organ.

HATSCHEK (1884, p. 49) is of the opinion that the terminal organ in the larva of *Sipunculus nudus* is a tactile organ, which is provided with tactile bristles. Judging from the conditions in the adults of this species it is the secretory threads that have been observed in larvae with the terminal organ protruded. Also SENNA (l.c., fig. 24) pictures an organ with bristles or ciila.

The Digestive Tract

The ciliated epithelium of the funnel-like oral disc (Pl. IV, fig. 7) continues in the narrow oesophagus. The next part of the digestive tract is called the stomach-intestine in HEATH's description. In the larvae described by him the oesophagus opens into an enlarged cavity, the stomach, which is successively transformed into a narrow intestine. The histological structures are the same in both parts of the tract. In the *Pelagosphaera* larvae described here the boundary between the stomach and the intestine is more distinct.

The longitudinally folded epithelium of the stomach is strongly vacuolated and only sparsely ciliated. It is obviously a glandular epithelium, the lightly stainable secretion is seen both in the distal parts of the cells and within the intestinal cavity. As has been discussed above two of the larvae have an aggregated mass of long prototroch cilia, mucous and intermingled with small plankton organisms, in the first part of the stomach. HEATH (l.c., p. 283) notes a similar observation: "Diatoms occur in this section fo the tract together with small quantities of some other material, all of it enveloped in a stringly looking coagulum."

In the median plane of the dorsal side there is an interruption in the vacuolated epithelium. Here the wall consists only of an ordinary columnar epithelium, the basement membrane and the delicate peritoneum. Probably this is the first rudiment of the ciliated longitudinal groove, which is to be found in the middle part of the digestive tract of all sipunculids.

The intestine forms a simple loop between the stomach and the rectum, which is in fact the proctodaeal part of the digestive tract. The diameter of the intestine is only about one third of that of the stomach. The glandular epithelium is of the same type, but in the intestine it forms circular folds.

In the posterior part of the intestine small dark granulae are found distally in the epithelium cells (Pl. V, fig. 8). Similar granulae are seen in nephridial cells of many sipunculids. It is possible that this part of the intestine has an excretory function. The dark granulae are especially abundant in the epithelium cells of a circular fold which forms the boundary between the intestine and the proctodaeum.

The proctodaeum is short and distally surrounded by a sphincter. The epithelium is longitudinally folded (Pl. V, fig. 9). In the proximal part it forms a ciliated columnar epithelium, which is covered with a delicate cuticula. In the distal part the cuticula successively increases in thickness and the cilia disappear. The epithelium is continuous with the epidermal layer.

The description given above agrees fairly well with that given by HEATH. However, HEATH makes a severe mistake when he describes the invaginated introvert as the first part of the digestive tract. He attaches great importance to a dorsal pouch-like diverticulum, which is nothing but that part of the inverted head which is limited ventrally by the conspicuous tentacle. As a result of the mistake he also discusses the similarities between the *Pelagosphaera* organization and that of an Echiuroid.

The posterior part of the intestine and the proctodaeum are attached to the body wall through parallel mesenteria. In the pouch-like cavity thus formed between the body wall and the intestine lymphocytes are probably formed. On the inner side of the mesenteria clusters of cells are seen which obviously are detached from the walls (Pl. V, fig. 10).

MINGAZZINI describes fat bodies, "sostanza adiposa", floating freely in the coelom. However, these structures are not some kind of yolk bodies but the large, multinucleate bodies, which in French literature are named the "vésicules énigmatiques". The present writer, who has observed these structures also in *Sipunculus nudus* and in the large *Golfingia species,* is of the opinion that lymphocytes are formed from these bodies.

The Nephridia

The interpretations of the origin and development of the sipunculid nephridia are diverging. According to HATSCHEK (1884) the nephridia in *Sipunculus nudus* are of purely mesodermal origin. In the pelagical stage the larvae have U-formed nephridia with both nephridiopores and nephrostomes, but during the metamorphosis they are transformed into stalked spherical vesicles without any rudiment of the nephrostome. According to GEROULD (1907) and ÅKESSON (1958) the nephridia have a double origin from both ectoderm and mesoderm. In *Golfingia gouldi* both nephrostome and nephridiopore are established in the four-day-old larvae, but in the yolk-rich larvae of *Phascolion strombi* no nephrostomes are visible before the three-week-stage.

In the *Pelagosphaera* larvae the nephridia are noted to be of the normal sipunculid type in the papers of MINGAZZINI, SENNA and DAWYDOFF. In spite of a careful histological examination, however, HEATH did not succeed in finding the nephrostomes. Besides the ordinary nephridia, »un véritable metanephridium«, DAWYDOFF also describes protonephridia from the earliest stages of his larvae. Probably he has mistaken the ventral glandular organ which is connected to the anterior end of the ventral nerve cord for the protonephridium. No observations from other *Pelagosphaera* larvae confirm his statement.

In the *Pelagosphaera* larvae from the »Galathea« expedition the nephridia are metanephridia of the normal sipunculid type (Pl. VI, fig. 11). They have a ventro-lateral position somewhat anterior to the middle of the trunk. The nephrostome is close to the body wall in the most anterior part of the region of attachment. Different from most adult sipunculids the bending to the U-form is not completely finished, the two inner walls have not disappeared, only fused to form a delicate lamella. In most sipunculids the nephrostome forms a ciliated funnel, but here it has the form of a semicircular fold. The side of the nephrostome which faces the body wall is lined with a nonciliated epithelium with large nuclei and very sparse cytoplasm. The ciliated cells on the fold all have curious vacuoles in that part of the cells which is opposite the ciliated surface.

The wall of the two shanks of the nephridium consists of a single layer of cuboidal epithelium cells, which is covered with a reticulated, extremely thin peritoneum. The cells are markedly vacuolated, near the nephridiopore they bear long cilia. Some cells are different in being pigmented with small pigment granulae similar to those in the epithelium cells of the posterior part of the intestine. In adult specimens of *Sipunculus nudus* all nephridial cells contain such granulae.

DISCUSSION

The *Pelagosphaera* larvae are the largest reported sipunculid larvae. In fact the specimens from the "Galathea" expedition have a volume several times that of adult sipunculids of many species, for instance *Golfingia minuta* and the members of the genus *Onchnesoma*. However, the larval characters are indisputable. First of all the absence of recognizable reproductive organs ought to be mentioned, but also the striking similarities with the well known larvae of *Sipunculus nudus* and the presence of typical larval organs – metatroch, inverse eyes and the glandular organ, all justifying the conclusion that the specimens studied are in larval stages.

Of the about 250 hitherto described sipunculid species the developmental history is known from only half a dozen. Four of these belong to the genus *Golfingia,* which is considered the most primitive among the genera. The development of *Phascolion strombi* is very similar to that of the *Golfingia* species. All these five species have a very short, lecitotropic pelagic stage or no pelagic stage at all *(Golfingia minuta)*. Different from these species *Sipunculus nudus* has a planktotropic stage of about one month. *S. nudus* differs also in many other details from the primitive type found in the other species (Hatschek 1884, Gerould 1903). However, nothing is known about the development of any members of the other genera, e.g., *Dendrostomum, Phascolosoma, Siphonosoma, Aspidosiphon* and *Xenosiphon.* Under such conditions it is quite impossible to refer the *Pelagosphaera* larvae to any single species, not even to any of the genera. From the descriptions in this and older papers it is evident that the *Pelagosphaera* larvae belong to a number of different species. The striking similarities between the *Pelagosphaera* larvae and the larvae of *Sipunculus nudus* were already pointed out by Senna (1906) and Spengel (1907). Also the histological structures of the *Pelagosphaera* larvae support an assumption that the animals are closely related. The epidermal organs are of the *Sipunculus type* (Åkesson 1958 pp. 227 ff.) as also the terminal organ and the tentacular eyes. However, the single tentacle dorsal to the oral disc and possibly also the glandular organ connect the larvae to the genera *Phascolosoma* and *Aspidosiphon.* Possibly the terminal organ is a primitive structure. It is found in adult condition only in the members of the genera *Sipunculus* and *Xenosiphon* disregarding the report of Cuenot (1902) that *Siphonosoma arcassonense* is provided with four glandular appendages around the terminal end. A similar glandular terminal organ is found in the larvae of *Golfingia elongata* from Roscoff (Åkesson 1961). Here the secretion of the organ adheres the larvae to *Zostera* roots and other objects in the intertidal zone.

With respect to the histology of the cerebral ganglion the *Pelagosphaera* larvae agree in most details with the genus *Sipunculus.* The central neuropile and the commissures have just the same relative position, the differences depend upon the turning around the transversal axis in the later developmental stages of members of the genus *Sipunculus.*

It is a well known fact that the metamorphosis can be postponed in many marine invertebrates if the suitable conditions do not exist (Thorson 1952). The considerable size of the *Pelagosphaera* larvae is perhaps reason for placing them in this category but the enormously developed metatroch which is specialized as a floating apparatus and for the collecting of food and is not seen in the planktotropic larvae of *Sipunculus nudus,* speaks in favour of an assumption that the *Pelagosphaera* larvae have normally a very long planktotropic pelagical stage. Nothing is known about the metamorphosis except the scanty observations in Dawydoff's paper.

To summarize, it is obvious that the *Pelagosphaera* larvae studied here belong to a species whose development is of the *Sipunculus* type. The most probable genera to which the species should be referred are *Sipunculus* or *Xenosiphon.*

SUMMARY

1. The material consists of four larvae which were collected by the "Galathea" Expedition. Similar sipunculid larvae have been described by other authors, the first time they were supposed to be adult, pelagical sipunculids.

2. The morphology of the larvae is described. They are slightly ellipsoidal when the introvert is withdrawn. The length is more than 10 mm. The body wall is thin and almost transparent. The longitudinal muscle layer is separated into 36 bundles. Two dorsal and one ventral pair of retractor muscles are attached on the large cephalic region. A single

tentacle forms the dorsal boundary of the funnel-like mouth. The duct of a large glandular organ opens in the ventral wall. A metatroch with large cilia surrounds the cephalic region. The intestine forms a simple loop between the mouth and the anus. The terminal end of the ventral nerve cord is connected with a terminal organ.

3. The morphology is compared with the morphology of other recorded *Pelagosphaera* larvae. It is concluded that the *Pelagosphaera* larvae must belong to at least 4, probably 5 different species.

4. The histology of the different regions is described. In many details the *Pelagosphaera* larva agrees with the structures found in adult or larval stages of *Sipunculus nudus.*

5. A hypothesis is put forward that the glandular organ which opens in the ventral median plane of the oral disc and the ventral sensory organ of the genera *Siphonosoma, Phascolosoma* and *Aspidosiphon* are homologous.

6. The metatroch cilia have a double function, forming both a floating apparatus and a food-collecting apparatus.

7. The taxonomic position of the *Pelagosphaera* larvae is discussed.

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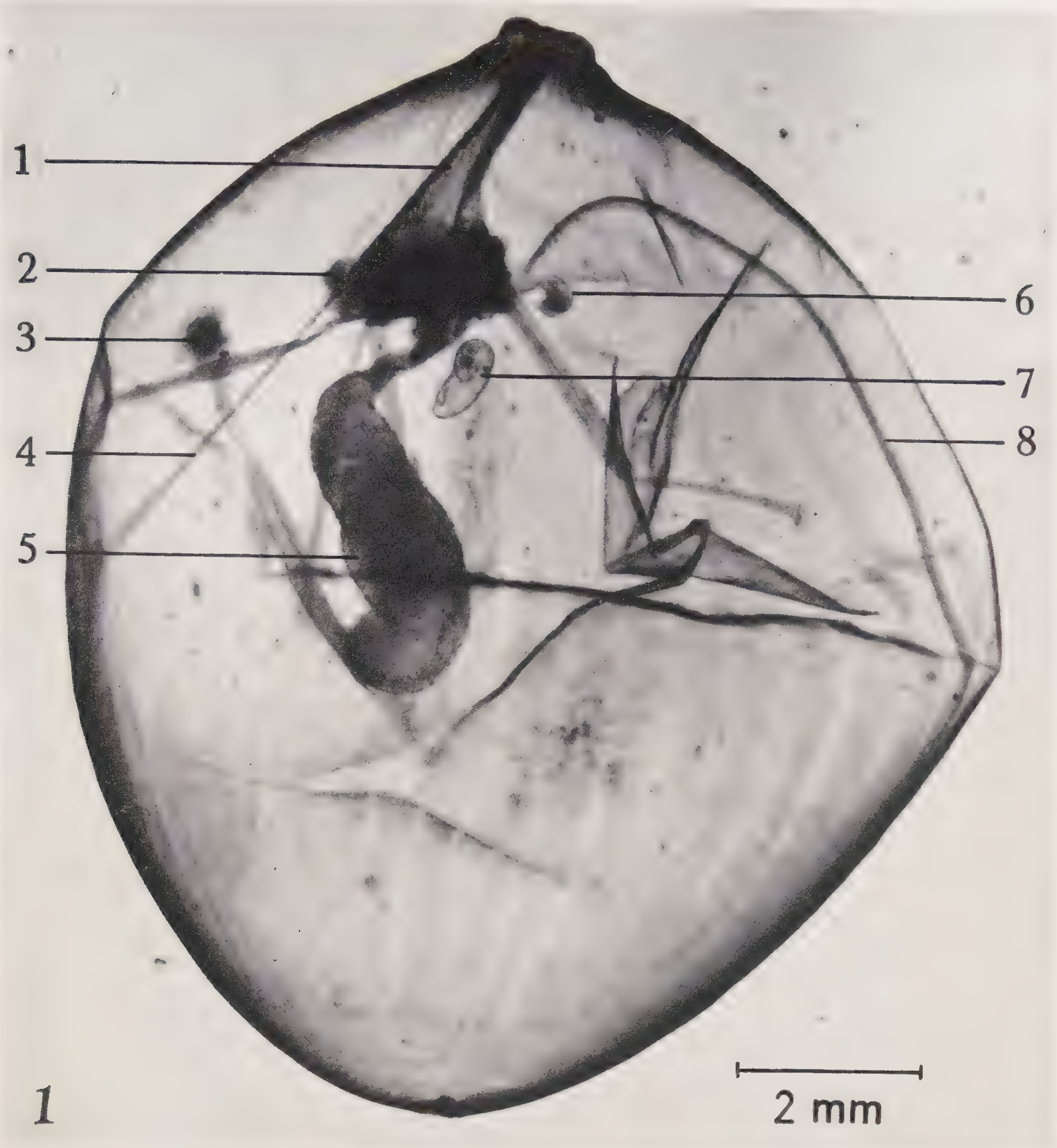

Fig. 1. *Pelagosphaera* larva with the introvert withdrawn. 1, introvert; 2, head; 3, anus; 4, retractor muscle (six retractors are seen); 5, stomach; 6, glandular organ; 7, nephridium; 8, ventral nerve cord. Photo: K. G. Wingstrand.

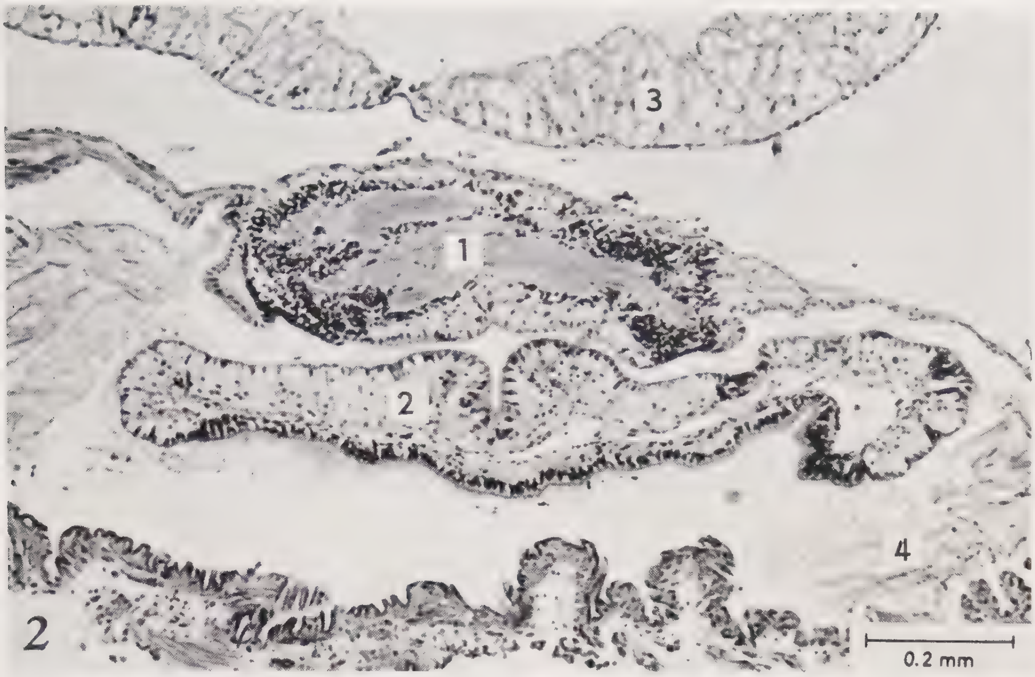

Fig. 2. A transverse section through the cerebral ganglion and the tentacle. 1, cerebral ganglion; 2, tentacle; 3, wall of the stomach; 4, long cilia of the metatroch.

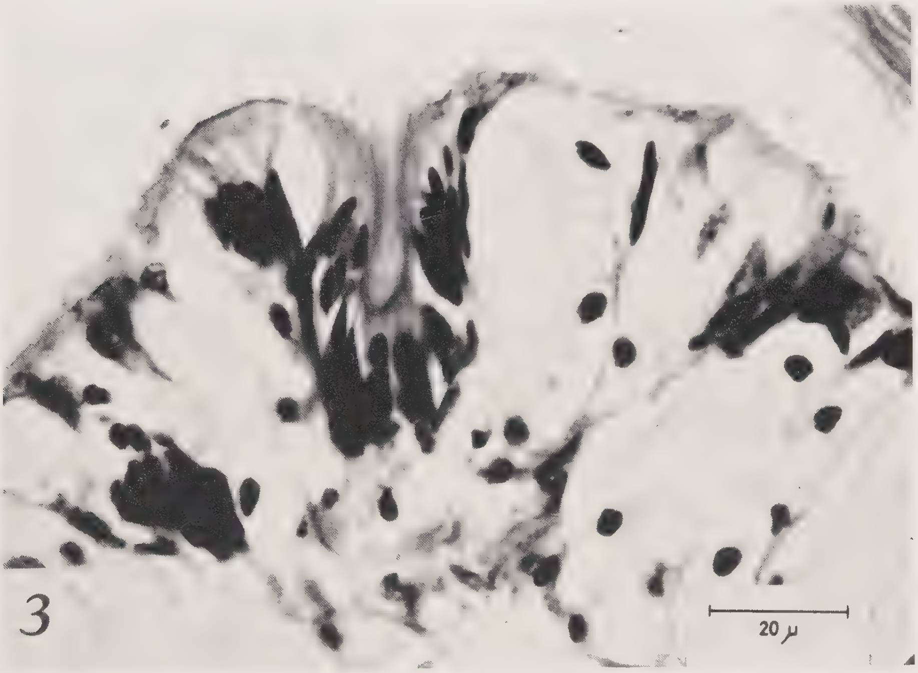

Fig. 3. A tentacular eye from the lateral part of the tentacle. Only a small area around the depression is ciliated.

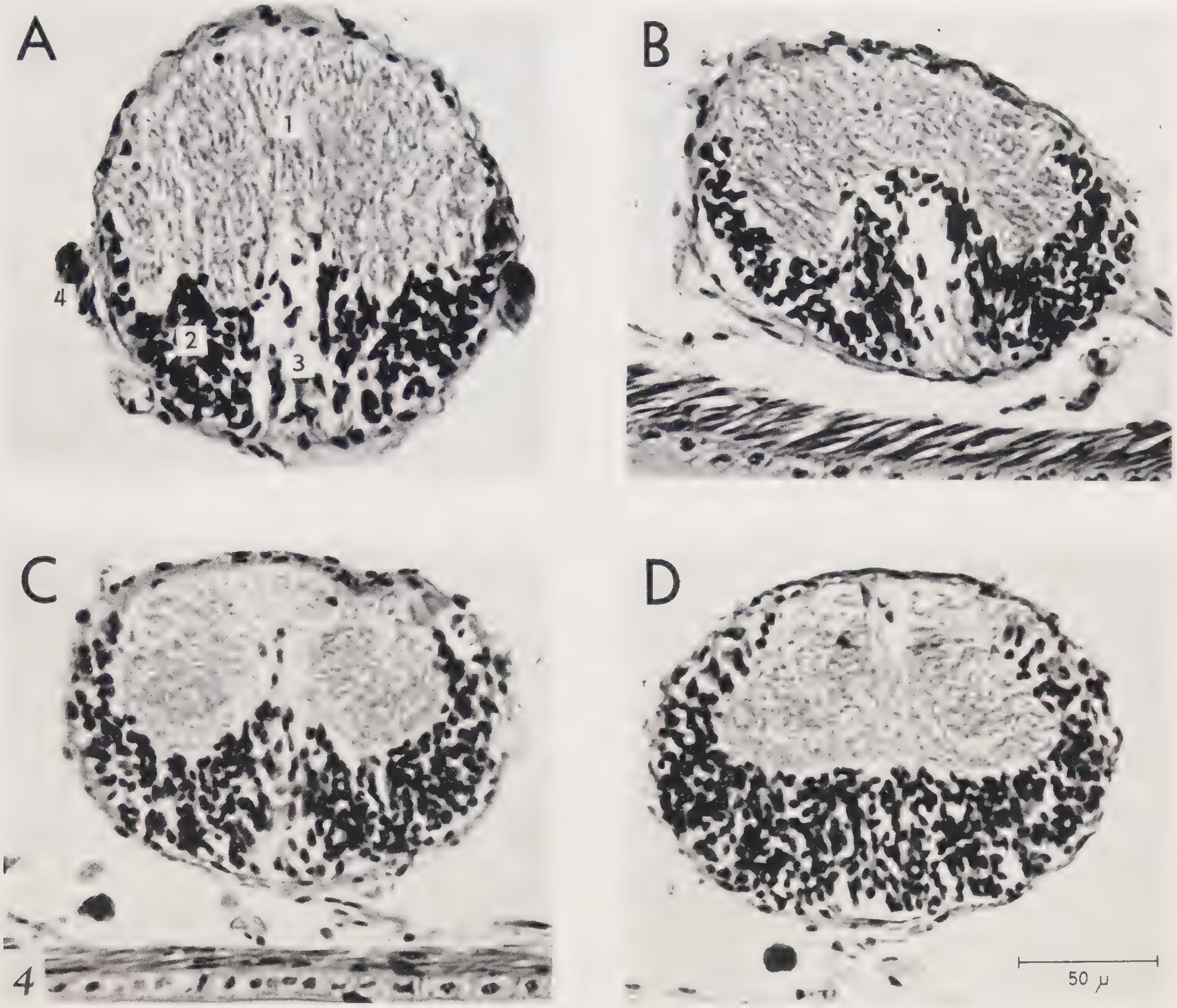

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Fig. 4. The ventral nerve cord in transverse sections. A, from the boundary between the introvert and the body; B, from the anterior part of the body; C, from the middle part of the body; D, from the end of the nerve cord; 1, neuropile; 2, nerve cells; 3, regeneration cells; 4, paraneural muscle.

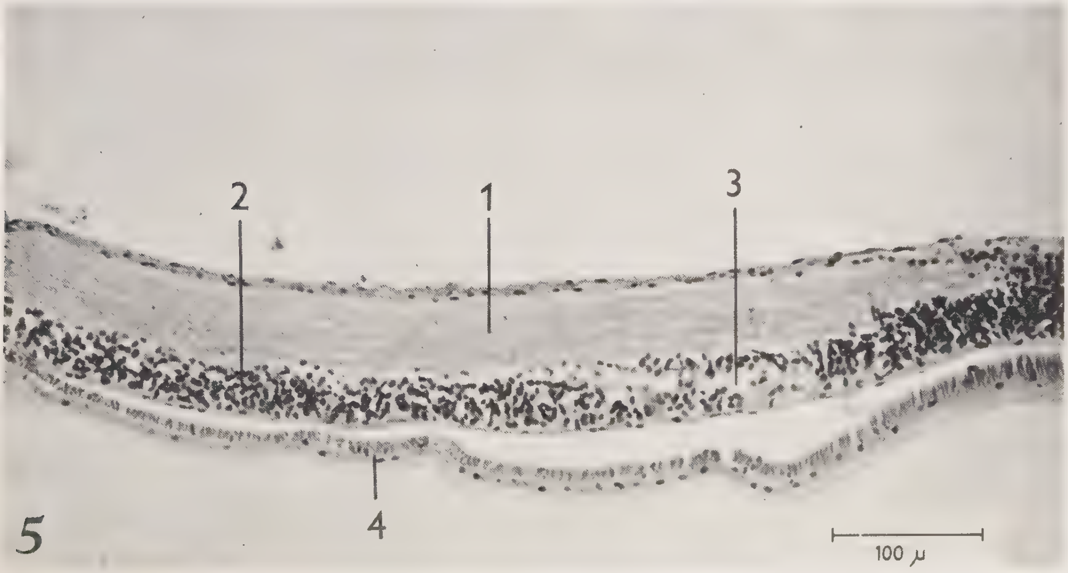

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Fig. 5. Parasagittal section through the ventral nerve cord. Note the proportions of the nerve cord and the extremely thin body wall; 1, neuropile; 2, nerve cells; 3, regeneration cells; 4, body wall.

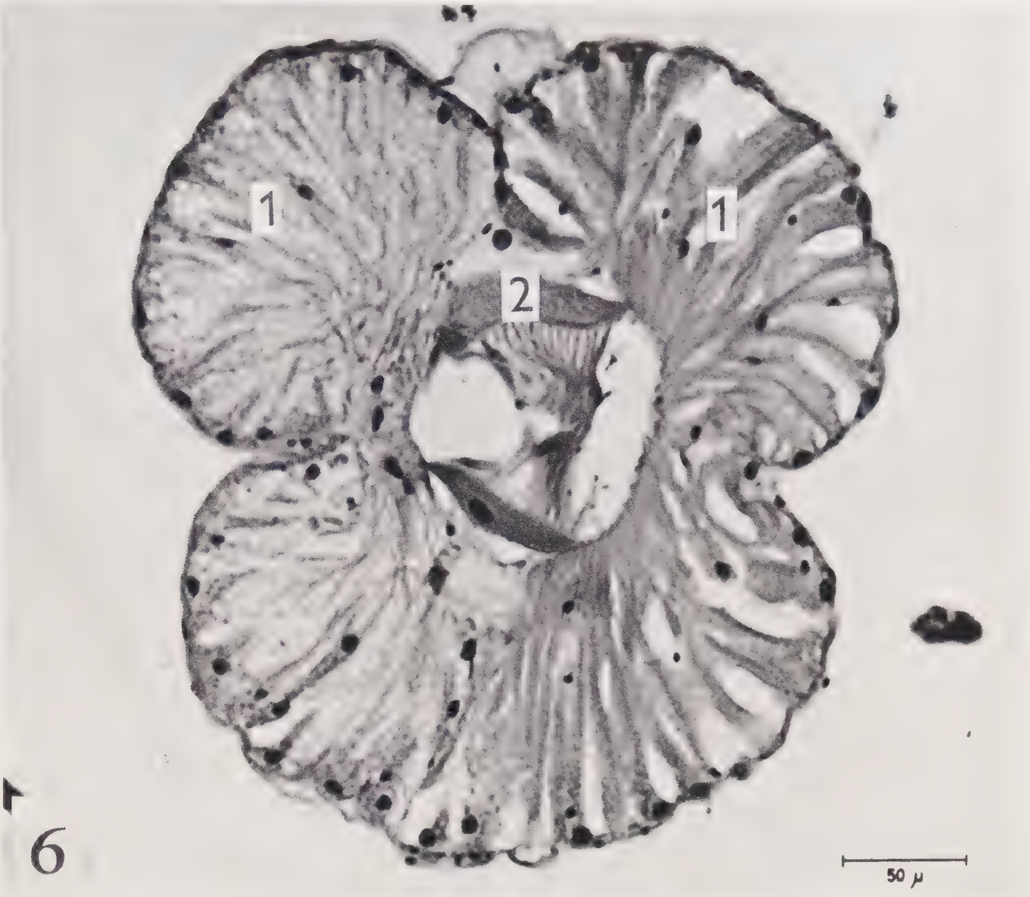

Fig. 6. The glandular organ in cross section. The right and left halves are in different phases of secretion. Two quadrants of the cavity consist of large ciliated cells. 1, gland cells; 2, arched ciliated cell.

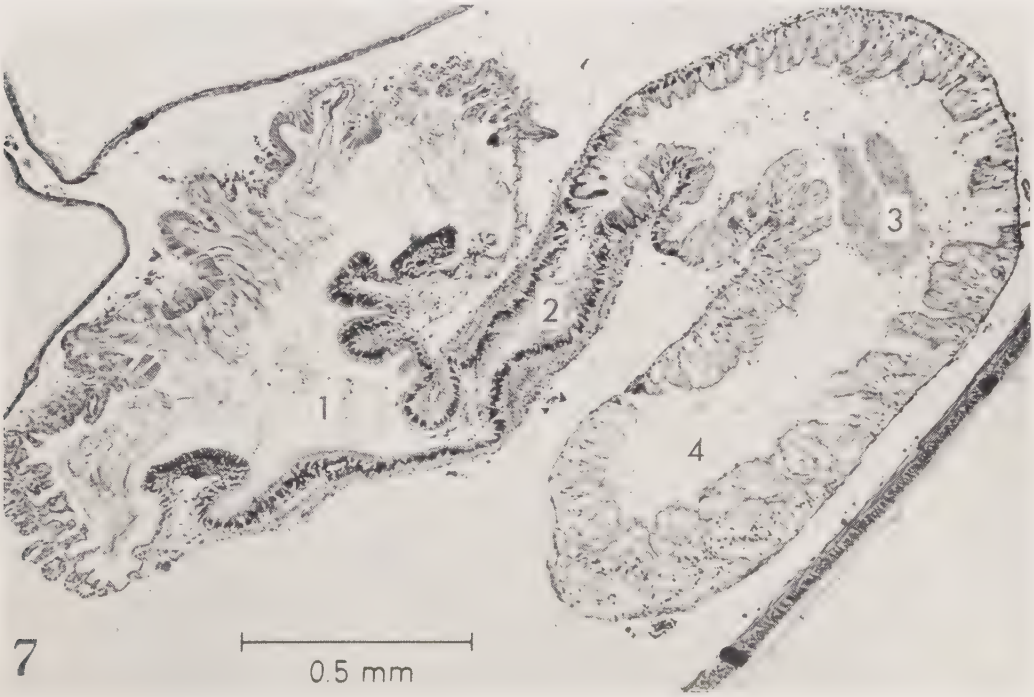

Fig. 7. The oesophagus and the stomach in parasagittal section. 1, mouth; 2, oesophagus; 3, coagulum; 4, cavity of the stomach.

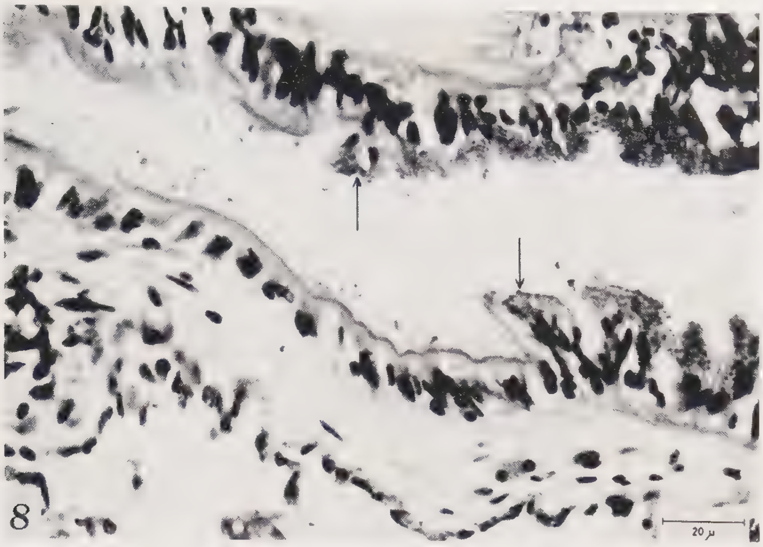

Fig. 8. The boundary between the small intestine (to the right of the arrows) and the proctodaeum. Note the granulae in the cells of the small intestine.

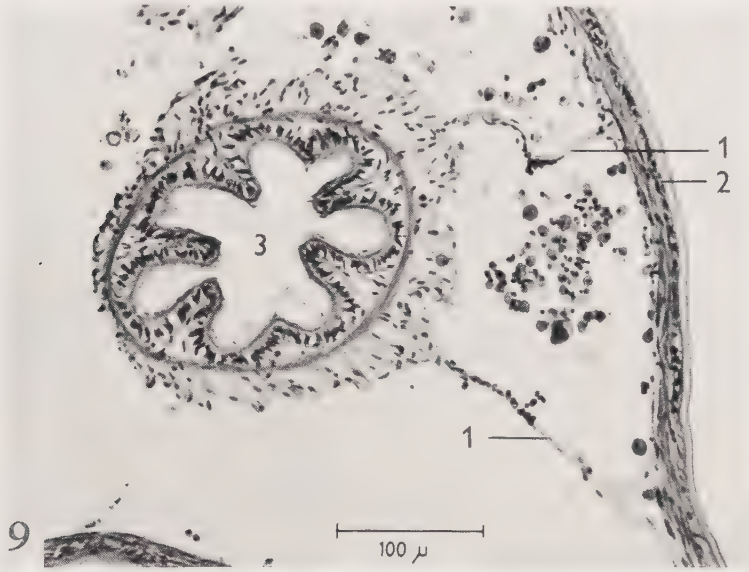

Fig. 9. A section through the proctodaeum and the mesenterial pouch between the proctodaeum and the body wall. 1, mesenterium; 2, body wall; 3, proctodaeum.

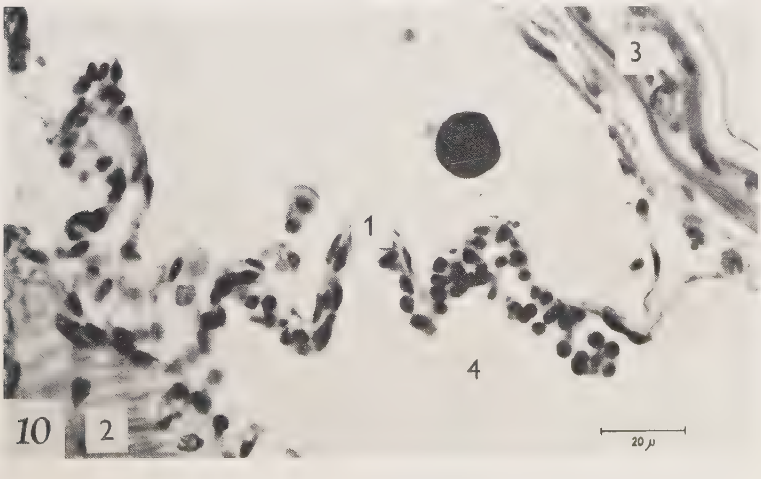

Fig. 10. One of the two mesenteria between the proctodaeum and the body wall. Lymphocytes are detached from the side which is directed toward the mesenterial pouch. 1, mesenterium; 2, wall of the proctodaeum; 3, body wall; 4, cavity of the mesenterial pouch.

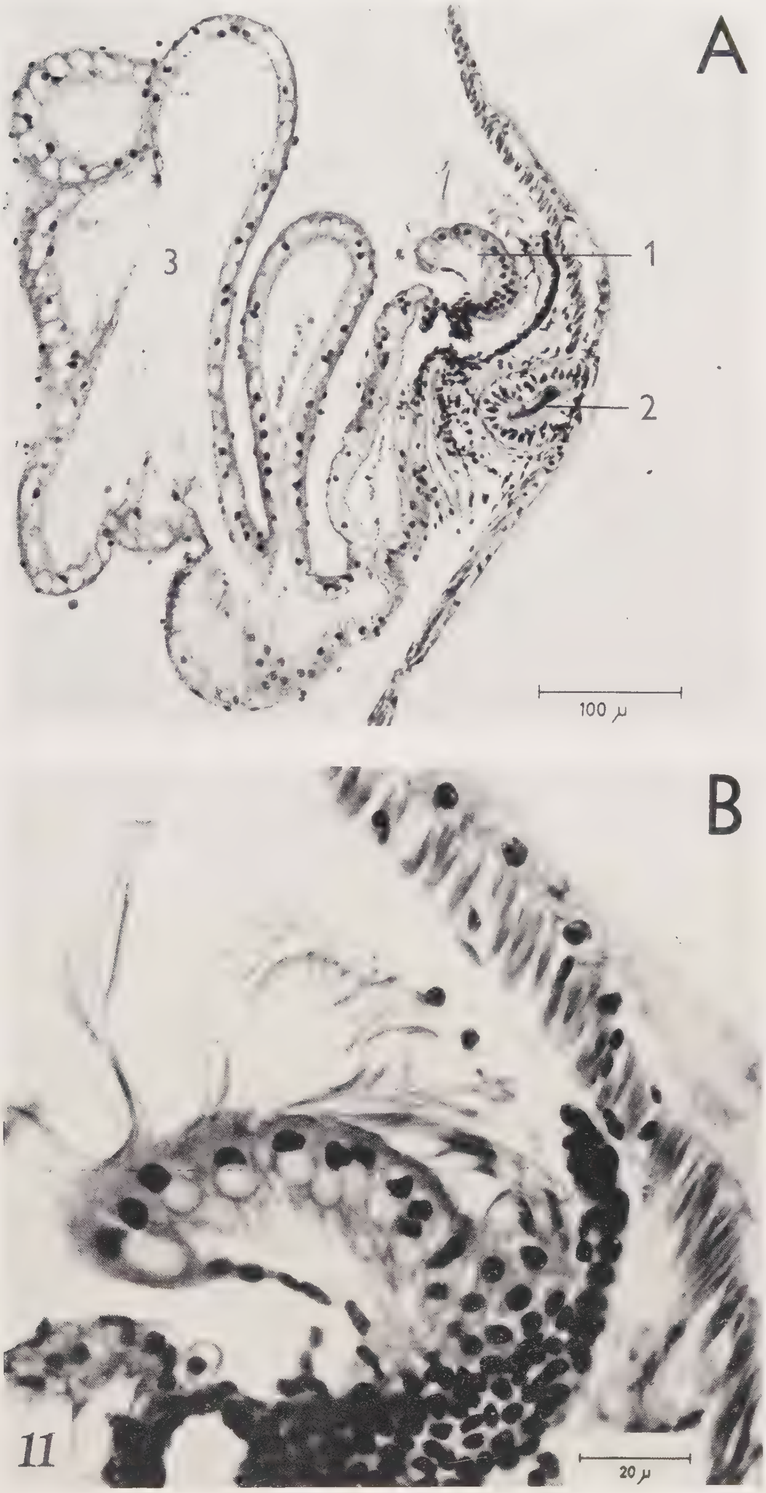

Fig. 11. The metanephridium of *Pelagosphaera*. A, the whole collapsed nephridium. Both the nephrostome and the nephridiopore is shown. B, section through the crescentic fold of the nephrostome. Note the vacuoles proximal to the nuclei; 1, nephrostome; 2, nephridiopore; 3, cavity of the nephridial sack.

ON THE IDENTITY OF THE SPECIES OF THE FISH GENUS *ARGENTINA* IN THE INDIAN OCEAN

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The eastern North Atlantic and Mediterranean fish *Argentina sphyraena* has been recorded twice from the western Indian Ocean, once by GILCHRIST and VON BONDE (1924:33) and once by PFAFF (1956: 148). As I have previously written (COHEN 1958), the specimens of the former authors were listed but not described, and have apparently been lost. The specimens collected by the Danish research vessel "Galathea" and noted by Dr. PFAFF have, however, been made available for study through the kindness of Dr. JØRGEN NIELSEN, to whom I express thanks.

Although I predicted that the eastern Indian Ocean argentinid would probably be referable to the genus *Glossanodon*, I must admit error. Examination of the material taken shows that the species is quite plainly an *Argentina*, although not *A.sphyraena*. It is in fact much closer to *A.elongata*, though differing from all of the three named subspecies. As I have only two specimens and thus no idea as to the degree of variability of the taxonomic characters which I have used, it is with some trepidation that I predict the existence of a full species; however, this seems a wiser course than describing the form as a subspecies, a category which is even more dependent upon analysis of variation. Therefore I describe a species with the realization that when additional material is available re-evaluation and perhaps recognition as a subspecies will be necessary.

Argentina euchus n. sp.

Argentina sphyraena (non Linnaeus 1758) GILCHRIST and VON BONDE 1924, p. 3 (synonymy; St. 295, lat. 26°00'45"S., long. 33°19'50"E., 180 fms., St. 375, lat. 29°42'40"S., long. 31°39'20"E., 201 fms.). – BARNARD 1925, p. 128 (brief descr. from literature). – SMITH 1953, p. 96, fig. 127 (brief descr., from literature, fig. is *Argentina silus)*. – PFAFF 1956, p. 148 (off Natal).

Diagnosis. – This species can be distinguished from *A.sphyraena* and *A.silus* by its branchiostegal ray count of five rather than six; from *A.sialis* in having six gill rakers on the lower arm of the first gill arch rather than 14 to 21; from *A.striata* in having 17 pectoral rays, a low number of teeth on the palatines and vomer and 10 ventral rays, rather than 18 to 20 pectoral rays, a high number of teeth and 11 to 13 ventral rays; from *A.elongata* in having 10 ventral rays rather than 11 to 13 rays and having 48 to 49 lateral line scales rather than 51 to 54 lateral line scales. Some differences between *A.euchus* and the subspecies of *A.elongata* are summarized in table 1.

Counts and measurements (in mm.). – The holotype first followed by the paratype in parenthesis – Dorsal 11 (11); anal 12 (12); pectoral 17-17 (?-17); ventral 10-10 (10-10); gill rakers 2+1+6 (3+1+6); lateral line scale rows 48 (49); standard length 158 (146); preanal 131 (119); preventral 83.5 (76.5); predorsal 71.4 (60.2); prepectoral 46.0 (42.9); head length 45.2 (40.2); snout 16.6 (13.6); eye 14.1 (13.7); maxillary length 8.0 (7.1); maxillary width 2.8 (2.5); body depth at dorsal fin 23.4 (22.0); body width behind head 19.0 (17.0); depth of head 20.5 (20.5); least depth of caudal peduncle 9.4 (9.0); vertebrae in paratype 48.

Description. – Body elongate, almost rectangular in cross section, more strongly compressed posteriorly. Greatest depth at the origin of the dorsal fin, tapering to the caudal peduncle. The dorsal profile of the head descending in a very slight curve from the eye to the snout. The dorsal rim of the orbit projecting only very slightly, if at all, into the dorsal profile of the head. The interorbital is broad and flat between the supraocular canals, which are themselves raised slightly above the flat surface. Lateral to the canals the frontals slope down somewhat over the top of the orbit. The preorbital forms

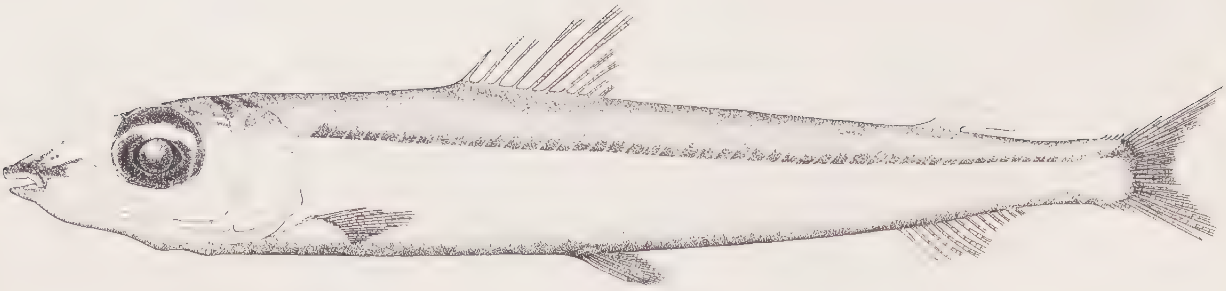

Figure 1. Paratype of *Argentina euchus* n. sp. Drawn by MIRIAM SCHAFFER.

a sheath which covers the dorsal edge of the maxillary when the mouth is closed. Sensory papillae are present on portions of the membrane covering the premaxillary. Both the upper and lower jaws are rounded when viewed ventrally. When the mouth is closed, the upper jaws project slightly. There is no knob at the symphysis of the lower jaws.

The palatines and the head of the vomer bear a continous band of small, closely spaced, posteriorly directed teeth. The band varies in width from a single tooth at the posterior ends of the palatines to as much as 5 or 6 teeth at the apex of the vomer. It is not possible to distinguish between vomerine and palatine teeth without dissection. The tongue bears 7 strong teeth. The gill rakers on the lower arm of the first arch are small, very widely spaced, roughly triangular in shape, and compressed. The base of the inner edge of each raker bears a fleshy pad. The rakers increase in size from the angle anteriorly, the largest being about as long as the maxillary is wide. The three rakers on the upper arm of the first arch are reduced to very small pointed structures.

The pectoral fin originates behind a vertical from the posterior tip of the opercles. The pectoral fin is inserted at an angle of about 40 degrees from the horizontal. The distance between the bases of the innermost pectoral rays is slightly less than the eye diameter.

The fin rays are all broken off short. Not a single scale remains on the specimens.

The ventral half of the body is light brown. An indistinct orange-brown band begins in the midline at the level of the origin of the dorsal fin and extends posteriorly, becoming wider and then almost disappearing on the caudal peduncle. The dorso-lateral part of the body is colored by dark brown chromatophores which are more densely distributed on the sides of the fish than on top. Above the lateral line the chromatophores are expanded and form a narrow but well defined dark brown line which runs the length of the fish, becoming indistinct only on the caudal peduncle, where it merges with a dark brown area along the base of the caudal fin. A single dark streak runs along the midline of the dorsum. The muzzle and the top of the skull behind the interorbital area are dark. The holotype is generally lighter than the paratype.

Holotype: A specimen 158 mm. in standard length, taken at "*Galathea*" St. 202 in the Indian Ocean, latitude 25°20′S., longitude 35°17′E., 590 m (Copenhagen University Zoological Museum No. 19519). Paratype: 146 mm. Data as for the holotype.

The name is derived from the Greek word *euchos,* the thing prayed for, and refers to the fact that this specimen is the answer to a longstanding puzzle.

Table 1. Comparisons between the holotype and paratype of *Argentina euchus* and the three subspecies of *Argentina elongata.* Measurements are expressed as percent of standard length.

Species	*A. euchus* *holotype*	*A. euchus* *paratype*	*A. elongata elongata*	*A. elongata australiae*	*A. elongata kagoshimae*
No. of examples	1	1	21	12	17
Ventral fin rays	10	10	11 (11-13)	12 (11-13)	12 (11-12)
Gill rakers on first arch	2+1+6	3+1+6	2 (1-3) +1+9 (8-10)	1 (1-2) +1+6 (6-7)	2 (0-3) +1+6 (5-6)
Lateral line scale rows	48	49	54 (51-54)	54 (51-54)	54 (51-54)
Preanal distance	82.9	81.5	82.8 (79.2-85.2)	83.8 (82.5-85.0)	85.0 (83.1-87.2)
Maxillary width	1.7	1.7	1.5 (1.3-1.6)	1.4 (1.2-1.5)	1.4 (1.2-1.5)
Body depth at dorsal fin	14.8	15.1	13.3 (11.9-15.3)	10.8 (10.1-11.5)	12.5 (10.4-14.7)
Head depth	13.0	14.0	12.1 (10.9-13.6)	11.0 (10.5-11.4)	11.1 (10.4-12.6)

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GAMMARIDEAN AMPHIPODA

FROM DEPTHS OF 400 TO 6000 METERS

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INTRODUCTION

The number of gammaridean amphipods known from abyssal depths exceeds 248 (J. L. BARNARD, 1961). It might have been expected that the extensive collections made by the *Galathea* would show diminishing returns of new abyssal and bathyal species, as it retraced in part the general areas of the *Challenger* and *Siboga* Expeditions, but a large part of the recoveries proved to be unique specimens of new species, as will be described herein.

This circumstance indicates the need for further extensive abyssal explorations in order to determine the distributional perimeters of abyssal amphipods, for about half of the known benthic species are based on one or two limited collections. Until this is accomplished it will be difficult to discuss the implications of the sketchy zoogeography now known.

The Gammaridea are largely benthic animals as opposed to the entirely pelagic Hyperiidea, but some gammarideans are pelagic, and it is difficult to determine their precise habitats except by indirect means. Many of the *Galathea* samples were taken with a Petersen grab, which collects only a benthic plug of sediment. None of the families collected in the grabs was unexpected, for all of them are well known as obligatorily benthic. Of course many new species were collected in these grabs. The bottom samples collected with open trawls and nets pose the major problem in habitat identification, for they collect not only in benthic sediments but in pelagic water layers. It is not satisfactory to assume that any species caught only in open trawls and not in grabs is a pelagic species, for the trawls collect much larger quantities of benthic organisms than the grabs. Many known benthic species were caught only in the trawls and because of the large area and speed of the trawling apparatus it is expected that fast moving demersal amphipods, which are facultatively benthic, would be caught more easily than in grabs. An attempt to determine the habitats of amphipods by analysis of gut contents was made by J. L. BARNARD (1961). The results were not clear-cut, but several species thought to be strictly pelagic were shown to feed on the bottom, the evidence pertaining to mineral particles in the gut contents. It is uncertain whether stray mineral particles might be forced into the stomach during collection and washing.

Most gammaridean amphipod families are strictly benthic in habitat but the large and abyssally important Lysianassidae are both pelagic and benthic and it is in this family that most of the habitat problems remain. In doubtful cases, and wherever unique specimens would not be totally destroyed I have examined gut contents; however, taxonomy and morphology are the prime concerns of this paper and it remains for the future worker with larger quantities of material to study the food problem. It also will be desirable to use more open-closing nets in abyssal depths especially near the bottom and to use open-closing epibenthic trawls.

To the amphipod specialist many of the *Galathea* discoveries are amazing and peculiar. A new *Parargissa* off Atlantic Africa and its subspecific counterpart off Pacific Panama have been discovered. That these giant amphipods (55 mm) have remained undiscovered to this time indicates our ignorance of bathyal and abyssal faunas. The remarkable new genus *Eucallisoma* suggests perhaps that other amphipods similar to it remain unsorted as hyperiids in various museums, for the animal superficially appears to be a vibiliid. The still cloudy taxonomic status of giant amphipods assignable to *Eurythenes gryllus* suggests a direction for future studies. The remarkable discovery of a lysianassid, *Onesimoides chelatus,* that shows sexual dimorphism must be mentioned for it is the first case in this large family of 103 genera and 650 species. This peculiar species is an abyssal "wood borer" and the materials which verified the dimorphism were collected in a sunken *Nipa*-palm fruit. Still another genus of the fascinating cyphocarid series in the family Lysianassidae was discovered and it forms a neat link in the specialization of this pelagic group. The discovery of a sixth species of *Trischizostoma* now permits an assortment of the species into two groups of 3 each. The two groups are so widely divergent that two pathways may be suggested: division into two genera each with 3 species, or into two species, each with 3 subspecies. Since the species of the complex probably inhabit salps or medusae the problem involves possible correlation of phenotypes with hosts and the fact that potentially the species are widely distributed. A study of the correlations with hosts, water masses and geography would be intensely interesting, but it remains a difficult problem to collect the animals *in situ.*

The addition of two new species to the formerly unique benthic genus *Byblisoides* provides the outline of a remarkable bathyal latitudinal distribution. The type species was collected from the Antarctic at 71° S, and the two new species from 37° S in the Tasman Sea and 4° S in the Makassar Strait. The specific differences among the 3 species are less profound than in neighbouring genera but they are qualitative in nature. They distinctly demonstrate that barriers to gene flow occur in the bathyal across great distances but it must be remembered that only 3 collections have been made. New materials from bottoms intermediate between the type areas and correlated with basin configurations will be intriguing.

A new genus of benthic haustoriid (*Carangolia*) is described from both the Pacific and Atlantic Oceans indicating the ubiquity and diversity of the genus. It is such a small and peculiar genus that it may have been mistaken for a broken rear end in the collections of earlier expeditions.

The addition of a third undoubted new abyssal species of *Leucothoe* to the literature suggests that this genus may be more widespread in the abyssal than heretofore considered and that it would be prudent for museum curators to look through collections of abyssal sponges and tunicates for what may be a wealth of amphipod material.

The rediscovery of *Alexandrella dentata,* belonging to the small and interesting family Stilipedidae suggests a problem in its habitats. The species was described from the Antarctic 71° S, 297 m, and collected by the *Galathea* in the Great Australian Bight at 37° S, 1340 m. The two Australian specimens are slightly damaged so that some systematic difference may have been destroyed but the writer believes that the collections are identical. Stilipedid amphipods lack mandibular molars, like the Pardaliscidae and Stegocephalidae. This fact plus the wide distribution of the aforementioned species may suggest a pelagic habitat, and perhaps an association with a salp or medusa.

The remarkable new pardaliscid genus *Pardisynopia,* with its inflated first and second pereopods sheds light on the relationships of an allied family, the Synopiidae, which may prove to correctly belong to the Tironidae.

The rich *Galathea* collections of Oedicerotidae and the difficulty with which they are placed generically has suggested to the writer a long overdue revision of the family. The problems revolve around the fact that most of the type species of the several genera were described from shallow waters and, as such, were oculate. The generic distinctions have been based on the eye structures, but most bathyal and abyssal species are eyeless and not readily assignable to genera. For this reason, I have constructed a new key to the family, based wherever possible on criteria other than eyes. It is sensible to believe that the loss of eyes with depth is assorted polyphyletically and is not a measure of generic distinctiveness.

Another species associated with sunken wood is *Bathyceradocus stephenseni* Pirlot, originally from the Moluccas Basin but found by the *Galathea* to range from Panama in the east to Madagascar in the west. It is strongly eurybathic. That some amphipod species have wide geographic distributions is not conclusive that the fauna of bathyal and abyssal depths is largely cosmopolitan but most certainly indicates the need for more intensive work such as that of the Galathea Expedition.

The addition of another new genus supposedly assignable to the Corophiidae emphasizes the difficulties which arise as more and more abyssal species are discovered. Trends to loss, simplification and intergradation are exhibited by some abyssal amphipods. The systematic position of the new genus *Aorcho* confounds the families Aoridae, Photidae and Corophiidae and demonstrates the weak distinctions of these assemblages as based on shallow water type-species. On the other hand, one must be cautious in abandoning convenient systems of arrangement for unique species inhabiting obviously paranormal environments.

No case can be made for a rule stating that simplification and loss are typical or even the trend for abyssal and bathyal animals. The remarkable new genus *Runanga* in the Podoceridae is just one of the several new discoveries of highly specialized animals in the *Galathea* collections. The genus *Runanga* is unique in the Gammaridea for the enlargement of a coxa which appears to serve as a brood lamella on an animal so elongated and cylindrical that the normal brood lamellae fail to retain the eggs.

The writer is indebted to Dr. ANTON BRUUN and Dr. TORBEN WOLFF of the Zoological Museum, Copenhagen, for permission to work on this valuable collection. The writer is grateful to the Beaudette Foundation for supporting him during the tenure of the study and for providing the services of Mr. LAWRENCE HAUBEN, staff artist. Mr. HAUBEN drew the figures signed by him, inked the remainder of my pencil sketches and prepared the plates for publication. I am most grateful for this valuable assistance. M. POUL WINTHER drew the amphipod for Figure 5 and I am indebted for its use. The photograph in plate I was taken by Mr. DON OLLIS of Santa Barbara, California.

List of Amphipoda by Station

Abbreviation of gear: ST 300 and ST 600: sledge (Sigsbee, Agassiz) trawl 3 m and 6 m wide; HOT: herring otter trawl; SOT: shrimp otter trawl; TOT: triangular otter trawl (pelagic); S 200 C: stramin net, diameter 2 m, coarse (pelagic); PGIO.2 and PGO.2: Petersen grab (bottom sampler), covering 0.2 sq. m. E. F. D.: estimated fishing depth.

Stations

30, Monrovia-Takoradi. 0°42′N 5°59′W, 5160 m, clay, ST 300, 18. XI. 1950.
Orchomene ? *takoradia* n. sp., ? benthic, 1.

52, San Tomé-Cameroon. 1°42′N 7°51′E, 2550 m, SOT, muddy clay, 30. XI. 1950.
Onesimoides chelatus Pirlot, benthic, 1.

66, off Gabon. 4°00′S 8°25′E, 4020 m, S 200C (5300 m wire), 5. XII. 1950.
Cyphocaris challengeri Stebbing, pelagic, 1.
Eucallisoma glandulosa n. sp., pelagic, 1.
Eurythenes obesus (Chevreux), ?demersal, 1.
Euandania gigantea (Stebbing), pelagic, 1.

101, off Angola. 8°50′S 12°32′E, 990 m, greenish mud, ST 300, 12. XII. 1950.
Stegocephaloides attingens K. H. Barnard, demersal, 1.
Harpinia cinca n. sp., benthic, 1.
Bathymedon palpalis K. H. Barnard, benthic, 3.
fragments, 3.

137, off SW Africa. 20°04′S 11°56′E, 537 m, ST 300, 23. XII. 1950.
Metaleptamphopus membrisetata n. sp., ?habitat, 2.

183, Cape Town-Durban. 33°25′S 37°20′E, 5210 m, E.F.D. 3000-3600 m, S 200C, 28. I. 1951.
Eurythenes obesus (Chevreux), ?demersal, 1.
Orchomenella musculosa (Stebbing), caught here as pelagic, 1.

194, off Durban. 34°09′S 30°45′E, 4360 m, Globigerina ooze, SOT, 7. II. 1951.
Eurythenes gryllus (Lichtenstein), demersal, 1.
Parargissa galatheae n. sp., ?pelagic, 1.
Euandania gigantea (Stebbing), pelagic, 1.

196, off Durban, 29°55′S 31°20′E, 430 m, sandy mud with stones, ST 300, 14. II. 1951.
Eurystheus afer (Stebbing), benthic, 3.
Cerapus abditus Templeton, benthic, 2.

200, off Natal. 29°39′S 37°01′E, 5110 m, HOT, 18. II. 1951.
Eurythenes gryllus (Lichtenstein), demersal, 2.
Liljeborgia mojada n. sp., benthic, 1.
eusirid fragment, 1.

203, off Natal. 25°36′S 35°21′E, 730 m, HOT, 21. II. 1951.

Trischizostoma circulare n. sp., pelagic inquilinous?, 2.

218, Mozambique Channel, 13°41′S 46°40′E, 3340 m, E.F.D. 450-650 m, TOT, 28. II. 1951.

Cyphocaris faurei K.H.Barnard, pelagic, 2.

(*Cymadusa filosa* Savigny), surface drift, 2.

232, Madagascar-Mombasa. 9°03′S 49°22′E, 4930 m, HOT, 8. III. 1951.

Bathyceradocus stephenseni Pirlot, benthic, 1.

238, off Kenya, 3°23′S 44°04′E, 3960 m, Globigerina ooze, HOT, 13. III. 1951.

Anoediceros hanseni mozambis n. subsp., benthic, 2.

241, off Kenya, 4°00′S, 41°27′E, 1510 m, pure Globigerina, HOT, 15. III. 1951.

Euonyx biscayensis Chevreux, pelagic ?inquilinous, 2.

cf. *Tmetonyx caeculus* (Sars), ?benthic, 1.

Ampelisca gusta n. sp., benthic, 1.

Oediceroides wolffi n. sp., benthic, 3.

Lepechinella monocuspidata n. sp., ?demersal, 1.

Eusirus nevandis n. sp., pelagic, 1.

279, Seychelles-Ceylon. 1°00′N 76°17′E, 4320 m, ST 300, 8. IV. 1951.

Parandania boecki (Stebbing), pelagic, 1.

281, Seychelles-Ceylon. 3°38′N 78°15′E, 3310 m, Globigerina ooze, ST 300, 10. IV. 1951.

Byblis ceylonica n. sp., benthic, 1.

318, Bay of Bengal. 9°02′N 93°07′E, 1440 m, E.F.D. 800-1100 m, TOT, 5. V. 1951.

Cyphocaris faurei K.H.Barnard, pelagic, 1.

443, Mindanao Sea, 8°48′N 124°09′E, 1500 m, mud, many fragments of plants, ST 300, 16. VIII. 1951.

Bathyceradocus stephenseni Pirlot, benthic, 2.

450, Celebes Sea. 1°50′N 119°20′E, 4940-4970 m, HOT, 21. VIII. 1951, waterlogged *Nipa*-palm fruits.

Onesimoides chelatus Pirlot, benthic, 78.

453, Makassar Strait. 3°56′S 118°26′E, 2000 m, greenish clay, ST 300, 24. VIII. 1951.

Onesimoides chelatus Pirlot, benthic, 3.

Paronesimoides lignivorus Pirlot, benthic, 2.

Byblisoides arcillis n. sp., benthic, 1.

Bathymedon candidus n. sp., benthic, 1.

471, Sunda Trench, 10°26′S 114°15′E, 2990-2810 m, clay and vulcanic tuff, ST 300, 10. IX. 1951.

Phippsiella nipoma n. sp., ?demersal, 1.

Harpinia sp., benthic, 1.

477, S. of Bali. 9°01′S 114°48′E, 780 m, sandy clay, PGI 0.2, 11. IX. 1951.

Harpinia abyssalis Pirlot, benthic, 1.

fragment, 1.

491, Makassar Strait. 4°56′S 117°39′E, 1560 m, muddy clay, ST 300, 14. IX. 1951.

Byblisoides arcillis n. sp., benthic, 1.

548, Coral Sea. 230 m, PGI 0.2, 11.XI. 1951.

Parhalimedon tropicalis n. sp., benthic, 1.

554, Great Australian Bight. 37°28′S 138°55′E, 1340-1320 m, Globigerina ooze, ST 300, 5. XII. 1951.

Eurythenes gryllus (Lichtenstein), demersal, 1.

Procyphocaris primata n. sp., pelagic, 1.

Harpinia australis n. sp., benthic, 1.

Joubinella traditor Pirlot, pelagic, 1.

Alexandrella dentata Chevreux, possibly pelagic, 2.

555, Great Australian Bight, 37°31′S 138°44′E, 875 m, clay, a little sand, PGI 0.2, 6. XII. 1951.

Uristes velia n. sp., ?benthic, 1.

Gitanopsis difficilis n. sp., benthic inquilinous, 1.

Zobracho canguro n. sp., benthic, 1.

ampeliscids, benthic, 2.

556, Great Australian Bight, 37°18′S 130°43′E, 795 m, clay, PGI 0.2, 6. XII. 1951.

Oediceroides alcaldia n. sp., benthic, 1.

557, Great Australian Bight, 37°13′S 138°42′E, 680 m, clay, PGI 0.2, 6. XII. 1951.

Anoediceros hanseni Pirlot, benthic, 1.

574, Tasman Sea. 39°45′S 159°39′E, 4670 m, ST 600, 18.XII. 1951.

Eurythenes gryllus (Lichtenstein), demersal, 1.

575, Tasman Sea. 40°11′S 163°25′E, 3710 m, pteropod ooze, SOT, 19. XII. 1951.

Orchomenella cavimanus (Stebbing), demersal, 1.

Epimeria glaucosa n. sp., ?pelagic, 2.

601, Tasman Sea. 45°51′S 164°32′E, 4400 m, Globigerina ooze, HOT, 14. I. 1952.

Eurythenes gryllus (Lichtenstein), demersal, 1.

Hippomedon antitemplado n. sp., ?benthic, 1.

Hippomedon tasmanicus n. sp., ?benthic, 2.

Pseudonesimus abyssi tasmanensis n. subsp., ?pelagic, 1.

cf. *Oediceroides wolffi* n. sp., benthic, 1.

fragment, 1.

602, Tasman Sea. 43°58′S 165°24′E, 4510 m, bluish clay, ST 300, 15. I. 1952.

Eurythenes gryllus (Lichtenstein), demersal, 1.

607, Tasman Sea. 44°18′S 166°46′E, 3580 m, clay, HOT, 17. I. 1952.
Ambasiopsis robustus n. sp., ?pelagic, 1.
Aristiopsis tacitus n. sp., ?pelagic, 1.
Cyphocaris richardi Chevreux, pelagic, 1.
Eurythenes gryllus (Lichtenstein), demersal, 2.
Hippomedon concolor n. sp., ?benthic, 1.
Orchomenella cavimanus (Stebbing), demersal, 1.
Phippsiella nipoma n. sp., ?demersal, 1.
Oediceroides wolffi n. sp., benthic, 1.
Oediceroides (Lopiceros) forensia n. sp., benthic, 1.
Lepechinella sucia n. sp., ?demersal, 1.
Amathillopsis grevei n. sp., ?benthic, 1.
fragment, 1.

626, Tasman Sea. 42°10′S 170°10′E, 610 m, Globigerina ooze, 20. I. 1952.

PGI 0.2
Uristes cansada n. sp., benthic, 1.
Ampelisca chiltoni Stebbing, benthic, 2.
Haploops descansa n. sp., benthic, 1.
Harpinia palabria n. sp., benthic, 21.
Paraphoxus pyripes K. H. Barnard, benthic, 2.
Arculfia trago n. sp., benthic, 2.
Pardisynopia tambiella n. sp., benthic, 1.
Monoculodes abacus n. sp., benthic, 1.
Oediceroides apicalis K. H. Barnard, benthic, 2.
Oediceroides limpieza n. sp., benthic, 2.
Melita? solada n. sp., benthic, 1.
Aorcho delgadus n. sp., benthic, 1.
Camacho bathyplous Stebbing, benthic, 1.
Runanga coxalis n. sp., benthic, 1.

HOT
Byblisoides esferis n. sp., benthic, 2.
Harpinia nadania n. sp., benthic, 1.
Joubinella traditor Pirlot, pelagic, 2.
Carangolia puliciformis n. sp., benthic, 4.
?*Syrrhoe affinis* Chevreux, ?benthic, 3.
Rhachotropis levantis n. sp., ?demersal, 2.

629, E. of Cook Strait. 41°46′S 175°48′E, c 2000 m, E.F.D. 1100-1300 m, TOT, 24. I. 1952.
Eurythenes gryllus (Lichtenstein), demersal, 1.

638, Wellington-Auckland. 37°33′S 175°57′E, 660 m, clay with a little sand, PGI 0.2, 26 I. 1952.
Ampelisca albedo n. sp., benthic, 1.

660, Kermadec Trench. 35°35′S 178°51′E, 7800-7310 m, ST 600, 22. II. 1952.
Parandania boecki (Stebbing), pelagic, 1.

662, Kermadec Trench, 36°22′S 178°23′W, 4630 m, HOT, 23. II. 1952.
Cyphocaris richardi Chevreux, pelagic, 1.
Eurythenes gryllus (Lichtenstein), demersal, 2.
Euandania gigantea (Stebbing), pelagic, 1.

663, Kermadec Trench, 36°31′S 178°38′W, 4410 m, brown sandy clay with pumice, HOT, 24. II. 1952.
Eurythenes gryllus (Lichtenstein), demersal, 11.
cf. *Oediceroides wolffi* n. sp., benthic, 2.
stilipedid, hyperiopsid, and 2 fragments.

665, Kermadec Trench, 36°38′S 178°21′E, 2470 m, grey clay, HOT, 25. II. 1952.
Valettiopsis multidentatus n. sp., ?habitat, 1.
Epimeria bruuni n. sp., ?benthic, 1.
Camacho bathyplous Stebbing, benthic, 1.
fragment, 1.

668, Kermadec Trench, 36°23′S 177°41′E, 2640 m, clay, HOT, 29. II. 1952.
Camacho bathyplous Stebbing, benthic, 1.

716, Acapulco-Panama. 9°23′N 89°32′W, 3570 m, dark, muddish clay, HOT, 6. V. 1952.
Parargissa galatheae americana n. subsp., pelagic, 1.
Haploops lodo n. sp., benthic, 7.
Leucothoe panpulco n. sp., benthic inquilinous, 2.
Epimeria sp., 2.
Rhachotropis sp., fragments of 3-4 specimens.

726, Gulf of Panama. 5°49′N 78°52′W, 3670-3270 m, clay, HOT, 13. V. 1952.
Cyphocaris richardi Chevreux, pelagic, 2.
Bathyceradocus stephenseni Pirlot, benthic, 25.
Rhachotropis sp., fragment, 1.

729, Gulf of Panama, 7°22′N 79°33′W, 875 m, green clay, PGI 0.2, 14. V. 1952.
Paroediceroides trepadora n. sp., benthic, 1.

742, Gulf of Panama. 7°28′N 79°37′W, 500 m, green clay, PGI 0.2, 16. V. 1952.
Ampelisca hermosa n. sp., benthic, 3.

743, Gulf of Panama. 7°27′N 79°37′W, 600 m, green clay, PGI 0.2, 16. V. 1952.
Heterophoxus oculatus (Holmes), benthic, 1.

745, Gulf of Panama. 7°15′N 79°25′W, 915 m, green clay, ST 600, 16. V. 1952.
Bathymedon covilhani n. sp., benthic, 1.
Melita lignophila n. sp., benthic, 1.

SYSTEMATICS

Except where some original contribution is made the diagnoses and detailed citations of families and genera are not included, for references to such may be found in J.L. Barnard (1958). In addition, authors' names of genera and species in keys are not included except where they have been published subsequent to Barnard's index.

The figures were prepared with the use of a microprojector, rather than a camera lucida and this accelerated the tedious job of illustration. En toto renditions were created by mounting a sagitally dissected animal for projection; from this the shape of the head, antennae, dorsal body curvature, urosome, uropods and the larger portions of the coxae were drawn and landmarks for later construction were indicated. The legs were added to the base figure from slides of flat mounted appendages. A slight artificiality results from this technique because most amphipods in the lateral aspect have the legs turned slightly obliquely; on the other hand, the legs as drawn are fully flattened in order to show the proper proportions, which by other means would be distorted. In some cases the first or second pereopods are omitted to avoid crowding, but in cases not clearly indicated the two appendages are similar. In most cases the pleopods are omitted.

Among the members of a genus the configuration of mouthparts is relatively uniform; the useless repetition of such drawings has been avoided, but in each case they have been compared with the type species of the genus; for new genera and species departing from the type species, some or all of the mouthparts have been drawn.

Because of the extensive illustrations, the descriptions of new species are limited to diagnoses.

FAMILY LYSIANASSIDAE

Key to the Ambasiid group

All lysianassids with the lower front corner of coxa 1 hidden by coxa 2 are assembled here. Dahl (1959) discussed a number of these genera and erected *Neoambasia*. References to the remaining genera may be consulted in J.L. Barnard (1958).

1. Pereopods 1-5 with long dactyls folded back on an inflated article 6 to form a nearly subchelate condition ...... *Metacyclocaris*
1. Pereopods 1-5 with normal short dactyls and unexpanded sixth articles 2
2. Mandibular palp attached level with molar 3
2. Mandibular palp attached behind molar 8
3. Upper lip projecting in front of epistome 4
3. Upper lip not projecting in front of epistome, the latter usually large and either projecting or dominating the upper lip 7
4. Coxa 1 half as long as its second article 5
4. Coxa 1 as long or longer than its second article 6
5. Gnathopod 1 subchelate ...... *Schisturella*
5. Gnathopod 1 simple ...... *Metambasia*
6. Outer plates of maxilliped lacking spines ...... *Ambasiopsis*
6. Outer plates of maxilliped spinose ...... *Neoambasia*[1]
7. Article 5 of gnathopod 1 shorter than article 6 ...... *Eurythenes*
7. Article 5 of gnathopod 1 longer than article 6 ...... *Valettiopsis*
8. Lobes of maxilla 2 broadly separated, the inner one pointing medially and of different shape than outer ...... *Aristias*
8. Lobes of maxilla 2 appressed and similar in shape 9
9. Article 2 of maxillipedal palp much broader than outer plate ...... *Ambasiella*
9. Article 2 of maxillipedal palp less than half as broad as outer plate 10
10. Palp article 4 of maxilliped vestigial, gnathopod 1 simple, mandible lacking molar ...... *Ambasia*
10. Palp article 4 of maxilliped well developed, claw-like, gnathopod 1 nearly chelate, mandible bearing large triturating mandible ...... *Aristiopsis* n. gen.

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[1] Dahl, 1959.

Ambasiopsis K. H. Barnard, 1931

Ambasiopsis K. H. Barnard, 1931: 425; K. H. Barnard, 1932: 44.

Revised diagnosis:

Upper lip linguiform, produced strongly in front of epistome; mandibular palp attached on level with molar; articles 5 and 6 of gnathopod 1 subequal, subchelate; coxa 1 small, largely hidden by coxa 2; telson cleft half to three fourths its length.

Remarks:

The following new species differs from K. H. Barnard's original diagnosis by the constricted inner ramus of uropod 2, by the strongly, not weakly subchelate first gnathopod, the long pereopods 3-5, and the less deeply cleft telson.

Ambasiopsis robustus n. sp.

(Fig. 1)

Material:

St. 607, Tasman Sea, 44°18'S 166°46'E, 3580 m, clay, HOT, 17. I. 1952. Holotype, male, 10 mm. Unique.

Diagnosis:

Gnathopod 1 strongly subchelate, palm nearly transverse; pereopods 3-5 long; third pleonal epimeron with rounded lower corner; pleon segment 4 only slightly convex dorsally; inner ramus of uropod 2 constricted; telson cleft halfway.

Relationship:

Differing from *A. georgiensis* K. H. Barnard and *A. uncinata* K. H. Barnard (see K. H. Barnard 1932: 44-46 for both) especially by the lack of a process on pleon segment 4, among numerous other characters.

The species is more closely related to *A. tumicornis* Nicholls (1938: 21) which is a species intermediate in its oblique palm on the first gnathopod but similar in its third and fourth pleonal segments. *Ambasiopsis robustus* differs from *A. tumicornis* by the palmar configuration of gnathopod 2 (for which figures should be compared), the constriction of the inner ramus on uropod 2, and the contrasting armature on the outer plate of maxilla 1.

The gills of pereopods 3 and 4 bear 4 or 5 pleats and one accessory lobe.

Aristiopsis n. gen.

Diagnosis:

Mouthparts not projecting and not styliform; epistome bearing a short conical anterior projection, below which it is straight; upper lip forming a small lobe which projects in front of the straight

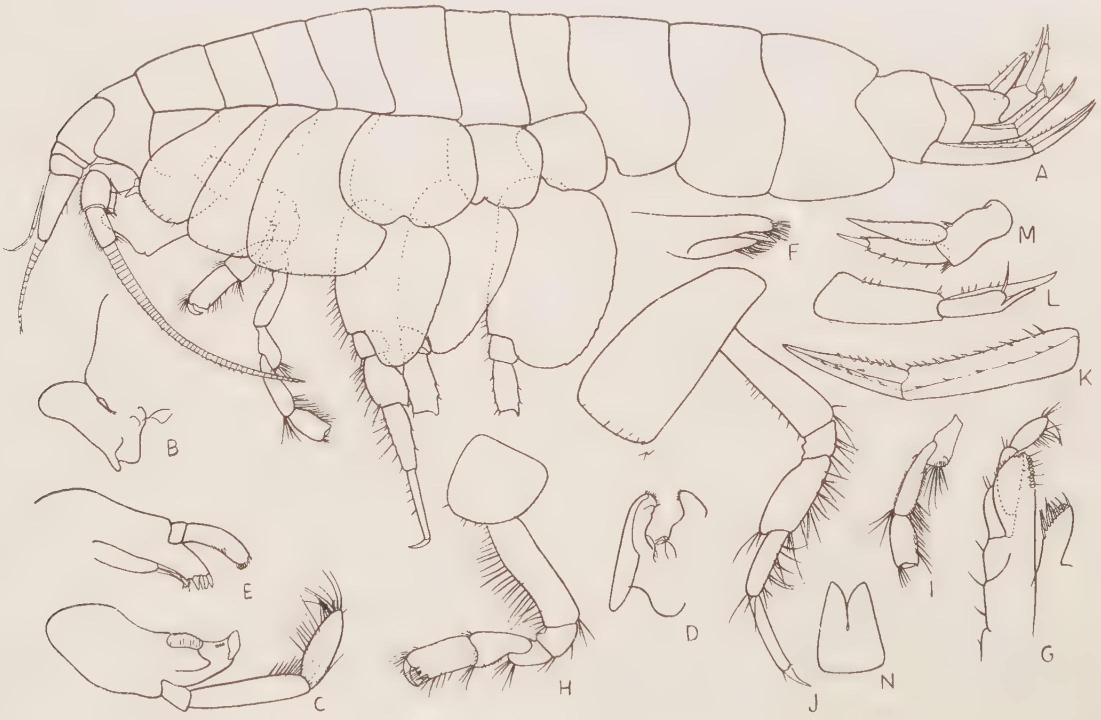


Fig. 1. *Ambasiopsis robustus* n. sp. Male, holotype, 10 mm, St. 607. A, lateral view; B, upper lip and epistome; C, mandible; D, lower lip; E, F, maxillae 1, 2; G, maxilliped; H, I, gnathopods 1, 2; J, pereopod 1; K, L, M, uropods 1, 2, 3; N, telson.

margin of the epistome; coxa 1 half as long as coxa 2 and largely concealed by it; mandible with well developed triturating molar, palp attached behind molar; primary cutting edge of mandible not toothed; maxilla 1 with 2-articulate palp; lobes of maxilla 2 similar in size and orientation; maxilliped with 4-articulate, slender palp, fourth article claw-like, outer plate spinose on inner edge; telson cleft less than half its length; gnathopod 1 with sixth article much longer than fifth, the palm protruding into a slightly chelate condition.

Type species: *Aristiopsis tacitus*, n. sp.

Relationship:

This genus represents still another assortment of criteria characterizing the ambasiid group of lysianassids. It is distinguished from *Schisturella, Metambasia, Ambasiopsis* and *Neoambasia* by having the mandibular palp attached behind the molar and thus is more related to the genera *Aristias, Ambasiella* and *Ambasia*. The first four genera mentioned have a strong triturating molar, similar to the new genus, while the last three genera mentioned either lack a molar or bear a weak and evanescent one, which lacks triturating ridges. In this way *Aristiopsis* assorts a strong molar with the palp attached behind it.

In the preceding key this genus seems to stand closest to *Ambasia* but as seen in the distinguishing couplet there is little resemblance. Actually it approaches *Aristias* more closely because of its epistomal configuration but differs by maxilla 2, as seen in the key, the ridged molar of the mandible, the inner plate of the first maxilla and other features.

The writer has attempted to minimize the importance of the first gnathopod and its nearly chelate condition, as well as the fact that article 6 is so much longer than article 5. The reason for this is that future discoveries may show it to be of little importance in the ambasiid group, where already other carcinologists have assigned species with subchelate and nearly simple gnathopods to the same genera. BARNARD (1961) already has shown the problems involved in the first gnathopods of the uristid complex, where he fused four genera. DAHL (1959) has tabulated the characteristics of some of the ambasiid group which is a helpful scheme for identification. He has questioned the condition of the mandibular palp and molar for *Ambasiopsis tumicornis* Nicholls, 1938, which he removed to a new genus, *Neoambasia*, but the writer believes reliance should be made on NICHOLLS' statement that the mandible of that species is similar to that of *Ambasiopsis georgiensis* (see K. H. BARNARD 1932) where the molar is well developed and the mandibular palp is attached over it. I have assumed this to be true and have based the preceding key on such.

Aristiopsis tacitus n. sp.

(Fig. 2)

Material:

St. 607, Tasman Sea, 44°18'S 166°46'E, 3580 m, clay, HOT, 17. I. 1952. Holotype, female with young, 7 mm. Unique.

Diagnosis:

With the characters of the genus.

Eyes absent; lower corner of head acutely produced; lateral lobes conical, but apices not sharp; basal unsegmented part of flagellum on antenna 1 longer than peduncle, basal part of accessory flagellum similar; third pleonal epimeron straight behind, rounded-quadrate at lower posterior corner; pleon segment 4 produced dorsally into a tent-shaped process, which is massive and not a keel; outer ramus of uropod 2 with a dorsal incision armed with a spine.

Cyphocaris challengeri Stebbing, 1888

Cyphocaris challengeri Stebbing, BIRSTEIN and VINOGRADOV 1955:212 (with references).

Material:

St. 66, off Gabon, 4°00'S 8°25'E, 4020 m, S 200C (5300 m wire) 5. XII. 1950. Male, 12 mm.

Distribution:

Cosmopolitan pelagic between the polar circles, known to occur between depths of 25 and 2200 meters, possibly deeper.

Cyphocaris faurei K. H. Barnard, 1916

Cyphocaris faurei K. H. Barnard, 1916: 117-120, pl. 26, fig. 4; SCHELLENBERG 1926: 215-216, figs. 2e, 11, 12, pl. 5, fig. 4; SCHELLENBERG 1929a: 195; K. H. BARNARD 1932: 36-37; PIRLOT 1933: 128; K. H. BARNARD 1937: 141-142.

Material:

St. 218, Mozambique Channel, 13°41'S 46°40'E, 3340 m, E.F.D. 450-650 m, TOT, 28. II. 1951. Two specimens, 28 and 27 mm.

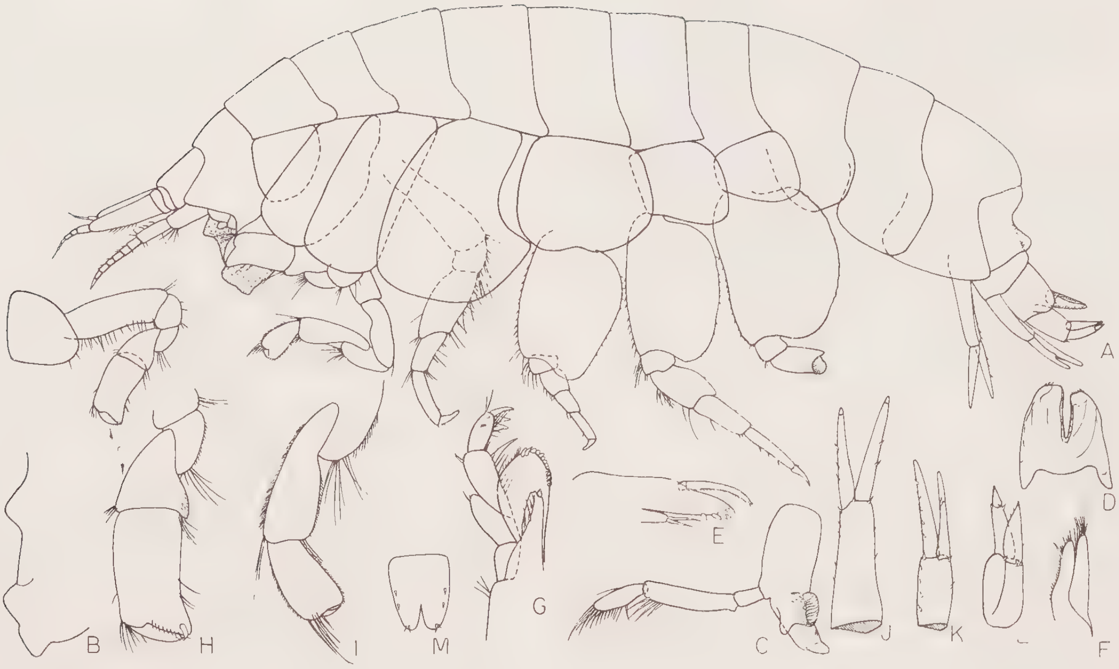


Fig. 2. *Aristiopsis tacitus* n. sp. Female, holotype, 7 mm, St. 607. A, lateral view; B, epistome and upper lip; C, mandible; D, lower lip; E, F, maxillae 1, 2; G, maxilliped; H, I, gnathopods 1, 2; J, K, L, uropods 1, 2, 3; M, telson.

St. 318, Bay of Bengal, 9°02′N 93°07′E, 1440 m, E.F.D. 800-1100 m, TOT, 5. V. 1951. Female, 20 mm.

Distribution:

Cosmopolitan bathypelagic, 175 to 2800 m.

Cyphocaris richardi Chevreux, 1905

Cyphocaris richardi Chevreux, J. L. Barnard 1954a: 53, pls. 2, 3 (with references); Birstein and Vinogradov 1955: 212-213, figs. 2, 3; Birstein and Vinogradov 1958: 221.

Material:

St. 607, Tasman Sea, 44°18′S 166°46′E, 3580 m, clay, HOT, 17. I. 1952. Male, 23 mm.

St. 662, Kermadec Trench, 36°22′S 178°23′W, 4630 m, HOT, 23. II. 1952. Female, 20 mm.

St. 726, Gulf of Panama, 5°49′N 78°52′W, 3670-3270 m, clay, HOT, 13. V. 1952. One specimen, 20 mm; one fragment.

Distribution:

Cosmopolitan bathypelagic. Known to exist below 4200 m in a haul reported by Birstein and Vinogradov as 7800-4200 m. Shallowest haul 76 m.

Eucallisoma n. gen.

Diagnosis:

Head very small, lacking lateral lobes but not deformed; antenna 1 immense, conical, first article almost 3 times as long as articles 2 and 3 combined, flagellum composed of one large basal article tipped with two smaller ones, accessory flagellum appressed to primary flagellum on inner face, composed of a large basal article and a minute apical one armed with a brush of sensory setae; antenna 2 small, slender; epistome produced forward into a bulbous keel, below which the upper lip is produced forward also, lower part of upper lip not formed into a flat plate guarding the mandibles but simply terminating in a small apically rounded cone; mandible with triarticulate palp attached over a small conical unridged molar; lower lip apparently lacking inner lobes (damaged in dissection); maxilla 1 with biarticulate palp, inner lobe densely setose on inner edge; palp of maxilliped 4-articulate; coxae all visible laterally; gnathopod 1 simple, article 7 vestigial, formed of a microscopic claw-like remnant shrouded by several cirri and bearing one or two anterior spinules; gnathopod 2 of the normal lysianassid structure; article 2 of gnathopod 1 sac-like, filled with a dense gland-like tissue formed of globular cells; rami of uropod 3 subequal in size; telson split about two thirds of its length.

Type species: *Eucallisoma glandulosa,* n. sp.

Relationship:

This is a remarkable genus of lysianassid, especially for its first gnathopod. The second article is sac-like and filled with globular cells but the connective tissues are solid and firm so that when incised the internal contents remain in place. Because both first gnathopods reflect this condition it is not an aberrancy. The genus is related to others which are believed to be semiparasites on salps or medusae and the peculiar first gnathopods may function as special secretory organs for paralysis, or digestion or for excretion of toxic waste products. It might be suggested that the peculiar tissues represent effects of parasitization by a gregarine or other protozoan.

Eucallisoma is a member of the scopelocheirid group of lysianassids, represented by the genera *Scopelocheirus, Scopelocheiropsis, Paracallisoma, Bathycallisoma* and *Aroui,* where the finger of the first gnathopod is vestigial. The distinctions among these 5 genera are rather minor and the new genus differs from them mainly by a combination of characters having quantitative value but certainly recognizable as distinctions. The immense first antenna and its peculiar accessory flagellum, the sac-like basos of the first gnathopod (if normal), the much more vestigial finger of gnathopod 1 and the lack of long shrouding setae all are characters unique to *Eucallisoma.*

Eucallisoma glandulosa n. sp.

(Fig. 3)

Material:

St. 66, off Gabon, 4°00′S 8°25′E, 4020 m, S 200C (5300 m wire), 5. XII. 1950. Holotype, ?male, 10 mm. Unique.

Diagnosis:

With the characters of the genus.

Third pleonal epimeron straight behind, slightly produced at lower corner; gland cone of second antenna well developed; eyes absent; anterior edge of article 2 on pereopod 3 densely spinose, but pereopods 4 and 5 poorly spinose; pereopods 1 and 2 similar in size and structure.

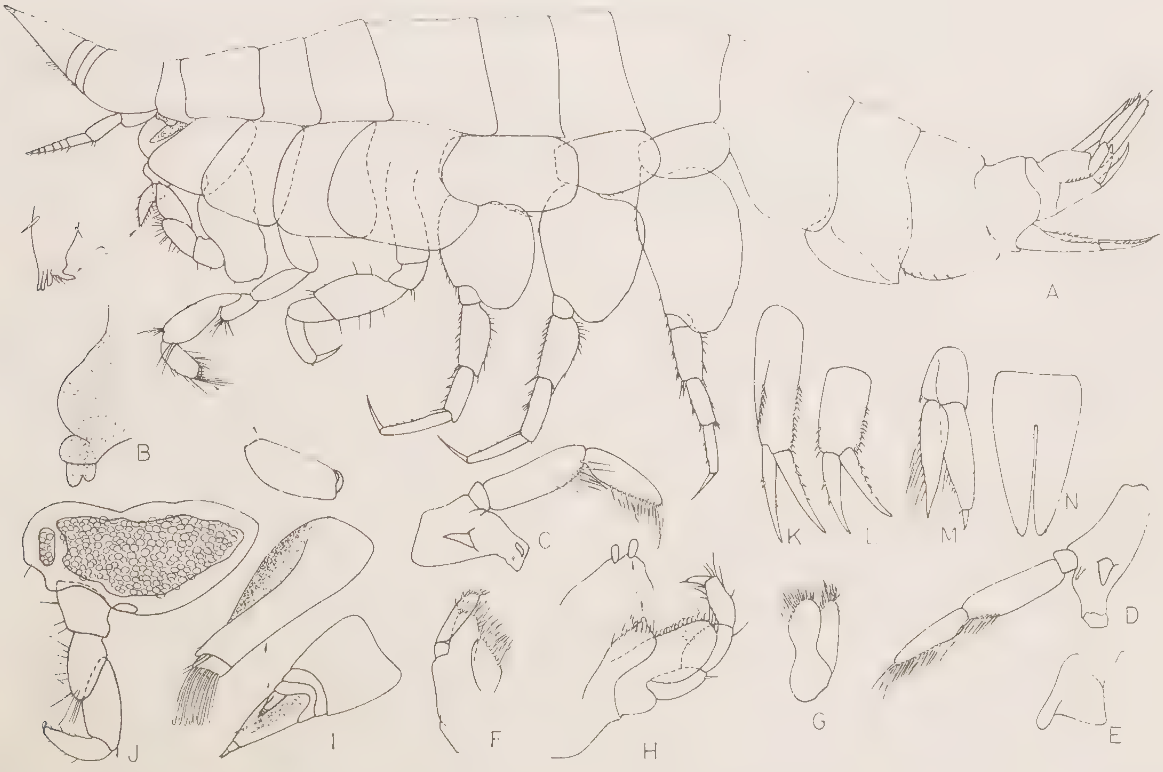


Fig. 3. *Eucallisoma glandulosa* n. sp. ?Male, holotype, 10 mm, St. 66. A, lateral view; B, epistome and upper lip; C, D, mandibles; E, lower lip, half; F, G, maxillae 1, 2; H, maxilliped; I, antenna 1; J, gnathopod 1, right side; K, L, M, uropods 1, 2, 3; N, telson.

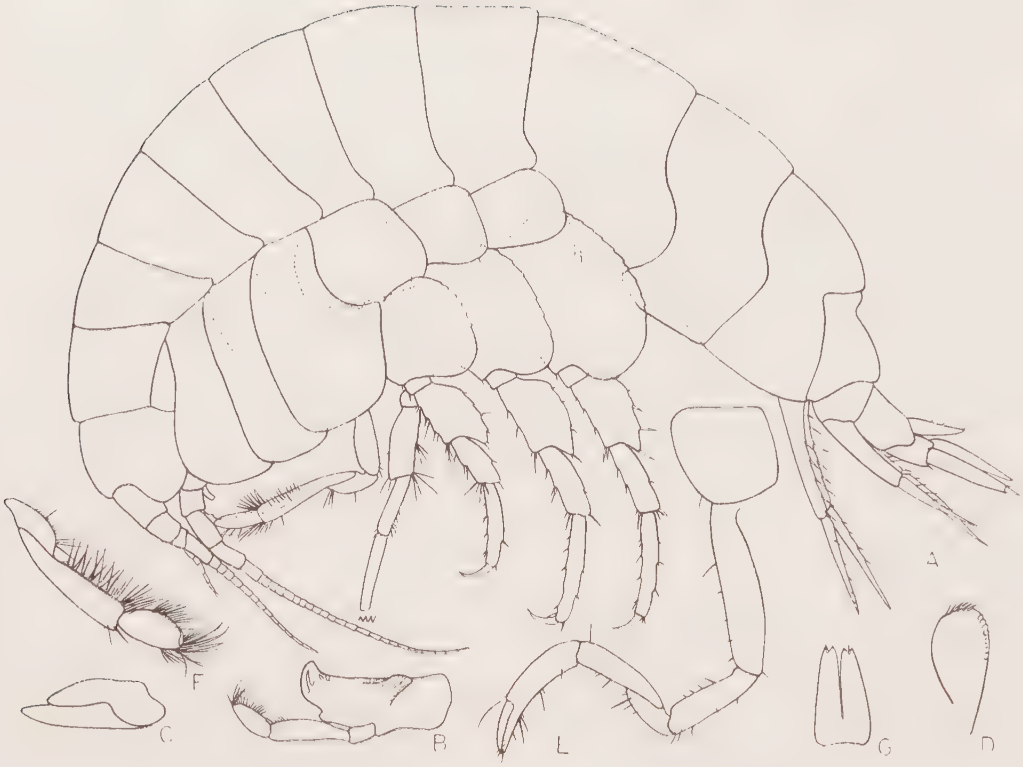


Fig. 4. *Euonyx biscayensis* Chevreux. Male, 8 mm, St. 241. A, lateral view; B, mandible; C, maxilla 2; D, outer plate ofm axilliped; E, F, gnathopods 1, 2; G, telson.

Euonyx biscayensis Chevreux, 1908
(Fig. 4)

Euonyx biscayensis Chevreux, 1908: 1-3, fig. 1; K. H. Barnard 1916: 110-112; Stephensen 1923: 42; Schellenberg 1926: 200-202; Chevreux 1927: 47; Chevreux 1935: 7-8, pl. 5, fig. 2.

Material:

St. 241, off Kenya, 4°00'S 41°27'E, 1510 m, pure Globigerina, HOT, 15. III. 1951. Male, 8 mm, figured; male, 15 mm.
Total: 2 specimens.

Remarks:

Several slight differences exist in the present material when compared with Chevreux' original figures; all of these appear to be differences in mounting and drawing techniques. On the present specimen the mandibular molar is more pointed and hairy, and lacks a triturating surface; the outer plates of the maxilliped have apical spines; the telson has an apical notch on each lobe; the third palp article of the mandible is slightly stouter; and the inner plate of maxilla 2 is slightly stouter. The eyes are scarcely visible.

Distribution:

Eastern Atlantic from the Faeroes to South Africa and in the Mediterranean, a species caught in pelagic equipment, maximum tow depths recorded from 564 to 1455 m.

Eurythenes Smith

Diagnosis:

Mandible with palp attached over molar; mandible bearing emargination accessory to cutting edge; lower lip with moderately thick mandibular lobes; maxilla 1 with biarticulate palp; inner plate setose only apically; maxilla 2 with inner plate conspicuously shorter than outer plate; antenna 2 with conspicuously curved and pointed gland cone; coxa 1 partly hidden and much smaller than coxa 2; coxa 5 rather large; gills probably pleated on both sides; gnathopod 1, article 6 nearly twice as long as article 5; article 6 of gnathopod 2 moderately slender but shorter than article 5; fourth article of pereopods 3-5 stout; telson deeply cleft.

Discussion:

This genus has been the source of considerable discussion in past literature and the systematic problems it poses are not yet solved. The type species *E.gryllus* (Lichtenstein) is very clear cut and well figured by SARS (1895: pl. 30). Another species which was assigned to *Eurythenes* was *Lysianassa magellanicus* Milne Edwards, 1848, collected at Cape Horn but later fused to the North Atlantic *E.gryllus* (see STEBBING 1906: 73). In 1905 CHEVREUX established *Katius obesus* n. gen., n. sp. which was transferred to *Eurythenes* by STEPHENSEN (1933). K. H. BARNARD (1932) discussed both *Katius obesus* and the genus *Eurythenes* extensively, pointing out the need to fuse the two genera. In 1933 STEPHENSEN fused *Katius obesus* with *Eurythenes gryllus* on the basis that *E.gryllus* represented the female and *K. obesus* represented males and juveniles. SHOEMAKER (1956) recorded the first definite large male of *E. gryllus,* which discovery refuted STEPHENSEN's position. In 1955 BIRSTEIN and VINOGRADOV erected *Eurythenes fusiformis* for a North Pacific species and in 1958 *E.microps.* In my 1958 Index to the Gammaridea I listed the four species of *Eurythenes* as *gryllus, magellanicus, fusiformis* and *obesus.*

In attempting to identify a large lysianassid represented by four medium sized specimens in Kermadec Trench it became apparent that the genus *Eurythenes* still has not been adequately discussed, nor that its composition is correct.

In the first place *E.fusiformis* Birstein and Vinogradov decidedly is not a *Eurythenes* but the writer is unable to suggest an existing genus to which it should be transferred. It is quite distinct from the type species *E.gryllus* on the following generic points: the lack of a marginal excavation on the mandible; the lack of a pointed gland cone on antenna 2; the long slender mandibular lobes of the lower lip; the elongated sixth article of gnathopod 2 which is longer than article 5; the subequal lobes of maxilla 2; the setosity of the inner edge of the inner plate of maxilla 1; the small fifth coxa; and the slender fourth articles of pereopods 3-5. From its comparative description it is apparent that *E. microps* is also of this type.

Secondly, it has not been pointed out that if one were to use STEBBING's key (1906:9) to the genera of the Lysianassidae the species *Katius obesus* would be placed in the genus *Tmetonyx* Stebbing because the third uropodal rami are lanceolate, not foliaceous as in *E.gryllus.* Thus, it must be determined whether *E.obesus* belongs with *Eurythenes* despite its third uropods and if so the diagnosis of *Eurythenes* must be emended. *E.obesus* differs from *Tmetonyx cicada,* the type species of *Tmetonyx,* in a number of features, which it also has in common with *Eurythenes* and thus should be retained with *Eurytheses.* These features are: the presence of a sharp gland cone on antenna 2; the sixth article of gnathopod 1 which is distinctly longer than article 5; the stout fourth articles of pereopods 3-5; and the small first coxa. These are features that should be used to distinguish *Eurythenes* from *Tmetonyx.*

Thirdly, the Kermadec specimens which I have identified with *E.gryllus* below must be determined generically. Like *E.gryllus* and *E.obesus* these specimens share the features noted above, the gland cone, second gnathopod, and fourth articles of pereopods 3-5. Unlike *E.gryllus* the third uropodal rami are lanceolate, not foliaceous, but the writer believes that *Eurythenes* should be emended in this respect, and that lanceolate rami may be characteristic of young specimens.

In summary the composition of *Eurythenes* should be emended as follows:

Eurythenes Smith S:
  gryllus (Lichtenstein) S, Gurj 51
  obesus (Chev), Schell 1955, was *Katius*
  fusiformis Birstein and Vinogradov, 1955 → removed to undetermined genus
  magellanicus (Milne Edwards) → *E.gryllus*
  microps Birstein and Vinogradov, 1958 → removed to undetermined genus.

Eurythenes gryllus (Lichtenstein, 1822)
(Figs. 5, 6, 7)

Eurythenes gryllus (Lcht.), STEBBING 1906: 73 (with references); STEPHENSEN 1933: 12-20, figs. 4-7 (in part); SHOEMAKER 1945: 186-187; STEPHENSEN 1949: 3-5; GURJANOVA 1951: 265-266, fig. 134; BIRSTEIN and VINOGRADOV 1955: 225; HURLEY 1957: 2; BIRSTEIN and VINOGRADOV 1958: 228.
Euryporeia gryllus, SARS 1895: 86-87, pl. 39.
not *Katius obesus* Chevreux, 1905: 1-5, figs. 1-3.

Diagnosis:

Dactyls of pereopods 3-5 short, about one third as long as article 6; combined length of articles 3-7 on the third pereopod twice as long as article 2.

Remarks:

The material will be discussed in units, rather than by listing it together.

St. 200, off Natal, 29°39′S 37°01′E, 5090-4880 m, HOT, gear not at bottom, 17. II. 1951. ?Female, 75 mm; male, 50 mm.

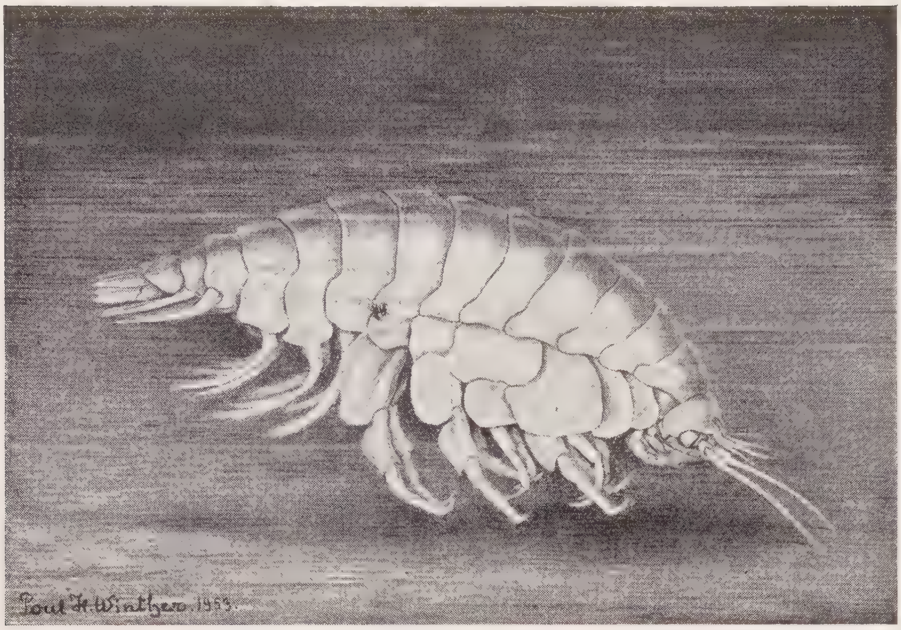

Poul H. Winther. 1953.

Fig. 5. *Eurythenes gryllus* (Lichtenstein). ?Female, 75 mm, St. 200. (POUL H. WINTHER del.)

Field color notes: male with legs, antennae, dorsal keel and lower edge of pleura very pink, the rest faintly pink; female with body white; eyes in both specimens yellow with faintly reddish tinge.

These giant specimens are in perfect condition, perhaps among the few ever so collected. The largest 75 mm lacks any evidence of genital papillae on the seventh pereon sternites and also lacks any evidence of brood plates so that it may be a gerontic female. The 50 mm specimen is definitely a male, bearing genital papillae on the seventh pereon sternites.

Both specimens correspond with SARS' (1895) drawings of the species, with the exception of two features: the epistome is not a large rounded plate in front, but a somewhat smaller bulbous piece bearing a frontal indentation above which the epistome is slightly folded into a lip; and the dorsal segmental carinae are much better developed. Instead of commencing on the last pereon segment the carinae begin on the first; they are low but distinct on segments 1 through 4, high on segments 5-7 and on pleon segments 1-4, low and slight on pleon segment 5 (absent in the male on pleon segment 5) and exist as a low bump on pleon segment 6. The carinae occupy the posterior surfaces of each segment: on pereon segment 1 the carina is one third as long as the segment, on segments 2-5 the carina is one half, on pereon 6 and 7, the carina is two thirds and on pleon segments 1-4 it is three fourths as long as its respective segment. The third uropodal rami are not quite as foliaceous as drawn by Sars. Despite these differences I have little doubt that the specimens are a variant population of *E. gryllus*.

This discovery of another unconfuted male *E. gryllus* (see SHOEMAKER 1956) with the pereopodal structure typical of SARS' drawings seems to contradict the studies of STEPHENSEN (1933), who reached the conclusion that all *E. gryllus* types were females and that males and young were represented by the form originally described as *Katius obesus* Chevreux 1905. Further indications that this conclusion was fallacious will be seen in the juvenile materials which are probably young *E. gryllus* and are decidedly not *E. obesus*.

With the exception of the last material to be cited, all remaining specimens were collected in stations made in the south Pacific Ocean. None of the specimens approach the great size of the first two and several minor differences occur in the material from normal adult structures.

Stations

554, Great Australian Bight, 37°28′S 138°55′E, 1340-1320 m, Globigerina ooze, ST 300, 5. XII. 1951. Female, ovigerous, 23 mm.

574, Tasman Sea, 39°45′S 159°39′E, 4670 m, ST 600, 18. XII. 1951. Female, 22 mm.

601, Tasman Sea, 45°51′S 164°32′E, 4400 m, Globigerina ooze, HOT, 14. I. 1952. Specimen, 21 mm.

602, Tasman Sea, 43°58′S 165°24′E, 4510 m, bluish clay, ST 300, 15. I. 1952. ?Male, 8 mm.

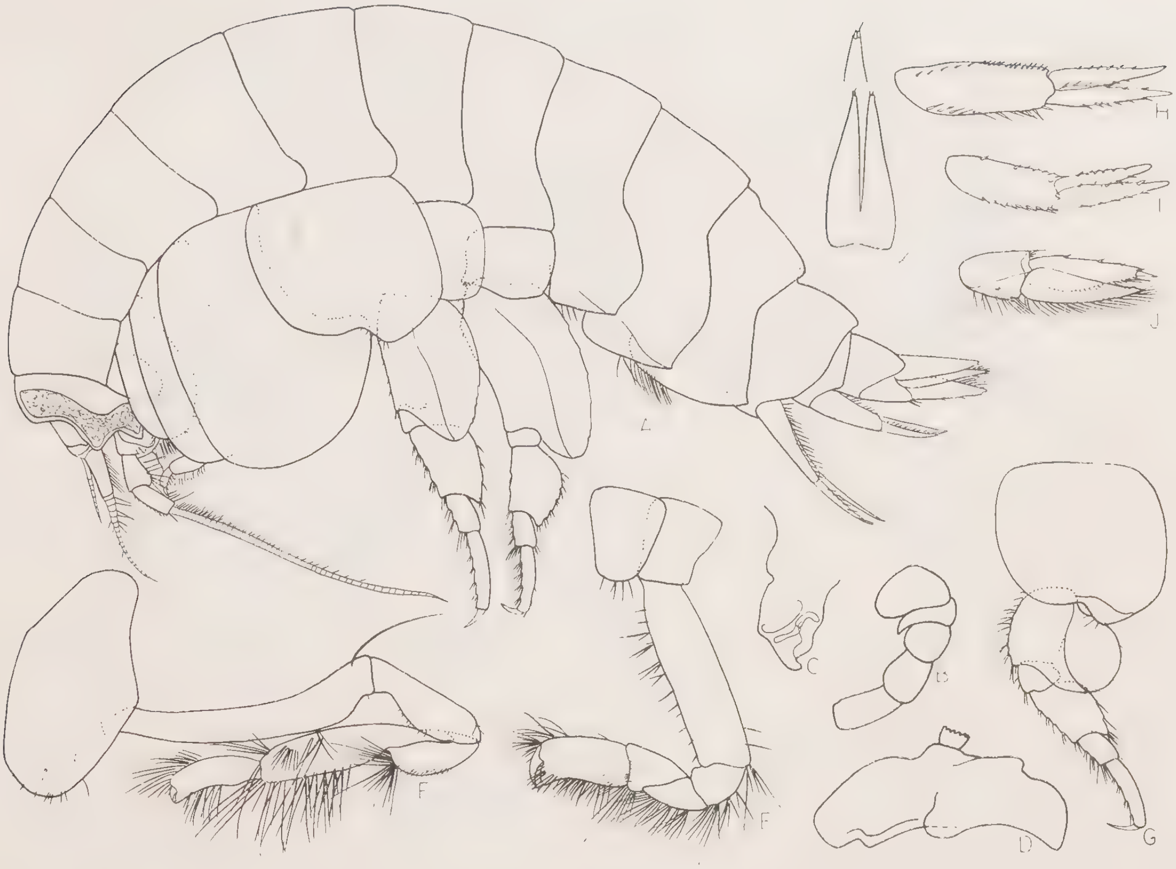


Fig. 6. *Eurythenes gryllus* (Lichtenstein). Female, 23 mm, St. 663. A, lateral view; B, antenna 2, stippling is article 2; C, epistome and upper lip; D, body of mandible; E, F, gnathopods 1, 2; G, pereopod 3; H, I, J, uropods 1, 2, 3; K, telson.

Stations

607, Tasman Sea, 44°18′S 166°46′E, 3580 m, clay, HOT, 17. I. 1952. Male, 18 mm; female, 17 mm.

629, E. of Cook Strait, 41°46′S 175°48′E, c. 2000 m, TOT + DR, 24. I. 1952. Female, ovigerous, 20 mm; field color note: body orange, eyes yellow.

662, Kermadec Trench, 36°22′S 178°23′W, 4630 m, HOT, 23. II. 1952. Female, ovigerous, 17 mm; female, 15 mm.

663, Kermadec Trench, 36°31′S 178°38′W, 4410 m, brown sandy clay with pumice, HOT, 24. II. 1952. Female, 23 mm; female, 29 mm; male 21 mm; specimen 13 mm; seven juveniles about 5 mm in length.

These young specimens, some of them obviously at sexual maturity most certainly represent the genus *Eurythenes*. The dactyls of the pereopods are short, like adult *E.gryllus*, and the dorsal notches of pleon segments 3 and 4 are beginning to develop on some of them. The principal difference of these young is the slightly chelate condition of both pairs of gnathopods. Young specimens of *E.gryllus* in the Atlantic Ocean have not been described, except by STEPHENSEN (1933) who described them as types similar to *Katius obesus* Chevreux, which he fused with *E.gryllus*. The writer is unconvinced that this is the proper analysis, because of the discovery in the present material from the south Atlantic Ocean of true males of the *E.gryllus* type, cited above. Until true juveniles of *E.gryllus*, bearing short pereopodal dactyls have been analyzed for gnathopodal structure in the Atlantic Ocean the writer believes that the present south Pacific material should be assigned to *E.gryllus*.

The distal spine on article 6 of pereopods 1 and 2 is proportionally large in the young material, 8 to 30 mm, but smaller in the 50 and 75 mm specimens. However, it is of the same linear dimensions in material of both sizes, indicating that it does not increase in size with age. The basal article of antenna 2 is considerably smaller in young animals but quite large and slightly bulbous in the large animals. The third pleonal epimeron is quadrate in the juveniles but rounded in large adults.

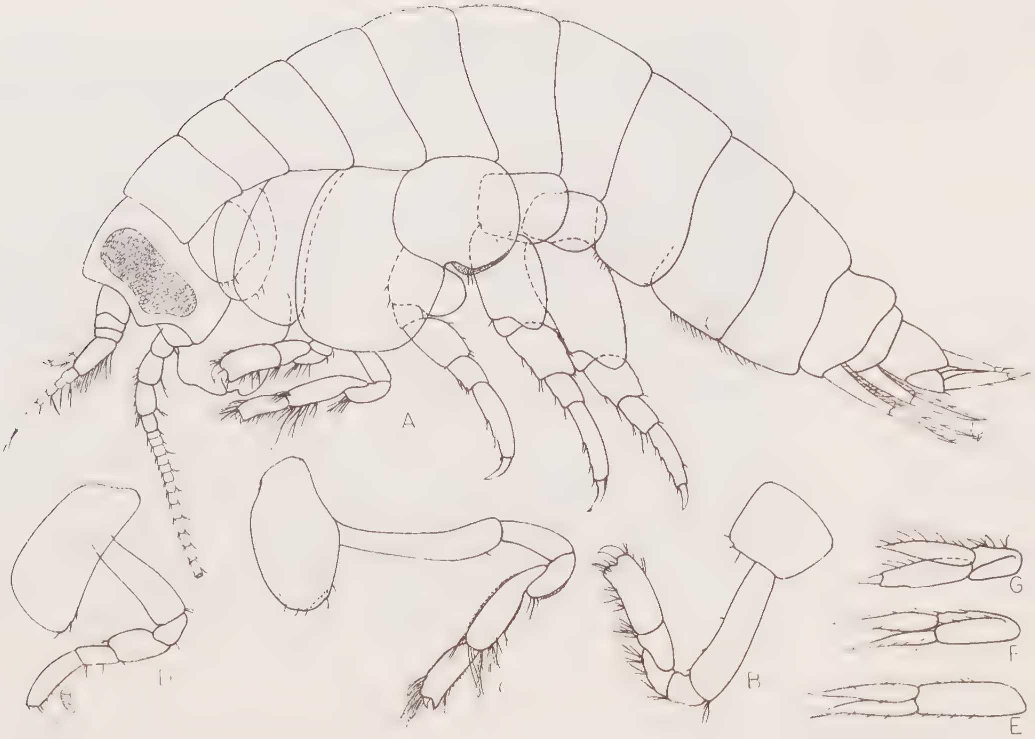


Fig. 7. *Eurythenes gryllus* (Lichtenstein). ?Male, 8 mm, St. 602. A, lateral view; B, C, gnathopods, 1, 2; D, pereopod 1; E, F, G, uropods 1, 2, 3.

St. 194, off Durban, 34°09′S 30°45′E, 4360 m, Globigerina ooze, SOT, 7. II. 1951. Badly damaged specimen, 18 mm.

Distribution:

North and south Atlantic Oceans, north Pacific Ocean (some perhaps of *E.obesus* type cited by BIRSTEIN and VINOGRADOV 1955 and 1958 as *E. gryllus),* caught in hauls as deep as 6500 m and as shallow as 184 m. The south Pacific material cited herein is only provisionally called *E.gryllus,* and may be similar to that cited by HURLEY (1957). Some of the south Pacific specimens show large quantities of mineral particles in the stomach, indicating benthic feeding but the species otherwise has pelagic adaptations, such as oily bodies and imperfect, diffused eyes.

Eurythenes obesus (Chevreux, 1905)
(Fig. 8)

Katius obesus Chevreux, 1905: 1-5, figs. 1-3; STEPHENSEN 1925: 126-127; SCHELLENBERG 1926: 217-218, fig. 26d; K.H.BARNARD 1932: 56-58, fig. 21, pl. 1, fig. 1; CHEVREUX 1935: 63-65, pl. 10, figs. 4, 6; pl. 11, fig. 10.
Eurythenes obesus, SHOEMAKER 1956: 177-178.

Material:

St. 66, off Gabon, 4°00′S 8°25′E, 4020 m, S 200C (5300 m wire), 5. XII. 1950. Juvenile, 9 mm.
St. 183, Cape Town-Durban, 33°25′S 37°20′E, 5210 m, S 200C, E.F.D. 3000-3600 m, 28. I. 1951. Male, 11 mm, figured.

Diagnosis:

Dactyls of pereopods 3-5 long, about 60 % as long as article 6; combined lengths of articles 3-7 on the third pereopod five times as long as article 2.

Remarks:

The species differs from *E.gryllus* by the very long distal parts of the pereopods, especially pereopod 3 and the long dactyls of pereopods 3-5.

STEPHENSEN (1933) believed that *K.obesus* was the young and male of *E.gryllus,* but SHOEMAKER (1956) discovered a true large male of *E.gryllus* and another one is reported herein.

The head of *E.obesus* seems much smaller than that of *E.gryllus*. Dorsal notches on pleon segments 3 and 4 appear to be developing in the present specimen, much as in the supposed young *E.gryllus* specimens reported above. However, the third pleonal epimera are rounded behind and not

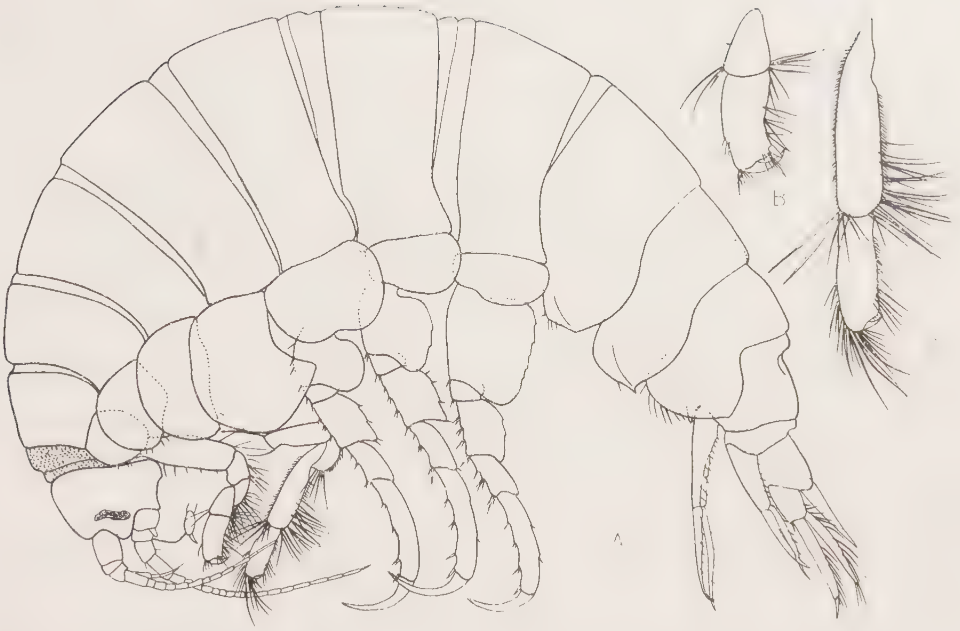


Fig. 8. *Eurythenes obesus* (Chevreux). Male, 11 mm, St. 183. A, lateral view; B, C, gnathopods 1, 2.

quadrate and the gnathopods show no evidence of slight chelateness seen in the young *E. gryllus* material.

Both *E. obesus* and *E. gryllus* bear the stout distal spine on article 6 of pereopods 1 and 2. The gills attached to the segments of gnathopod 2 and pereopods 1-3 in the *E. obesus* specimen at hand bear 3-4 broad proximal pleats.

Distribution:

Cosmopolitan between the polar circles, 5610-500 m.

Hippomedon antitemplado n. sp.

(Fig. 9)

Material:

St. 601, Tasman Sea, 45°51′S 164°32′E, 4400 m, Globigerina ooze, HOT, 14. I. 1952. Holotype, female, 15 mm. Unique.

Diagnosis:

Eyes absent, lateral lobes of head moderately acute; peduncular articles of first antenna not dentiform; third pleonal epimeron with a large blunt tooth detached from lower margin and lacking a notch; pleon segment 4 bearing a dorsal incision followed by a high keel-like carina terminating acutely; article 6 of gnathopod 1 with a distinct palm but not inflated, article 6 about two thirds as long as 5; epistome not produced, formed into a broad, flat lamina; coxae 1-3 with a microscopic notch on the lower posterior corners.

The mouthparts are like *Hippomedon denticulatus* (in Sars 1895: pl. 20) except for the much shorter third article of the mandibular palp; the mandible has 2 spines in the spine row. The gills of pereopods 5 and 6 each bear one slender accessory lobe.

Relationship:

Only four species of *Hippomedon* have any semblance of a carina on pleon segment 4. *Hippomedon antitemplado* differs from *H. frigidus* Stephensen, 1923 (p. 19) by the lack of a distal process on the first article of antenna 1 and by the shape of the third pleonal epimeron, with its tooth detached from the lower margin.

It differs from *H. holbolli* (in Sars 1895: pl. 21, fig. 2) by the more acute lateral lobes of the head, the lack of eyes, and the more dorsally situated tooth of the third pleonal epimeron, having the edge below it nearly vertical.

It resembles *H. longimanus* (Stebbing, 1888: pl. 13) from the abyssal North Atlantic more than other species but differs by the lack of a distal process on the first article of antenna 1 and the shape of the third pleonal epimeron, for which drawings should be compared.

It differs from *H. serratus* Holmes, 1905 (p. 473), by the lack of a process on the first article of antenna 1 and by the blunter, more remote tooth of the third pleonal epimeron.

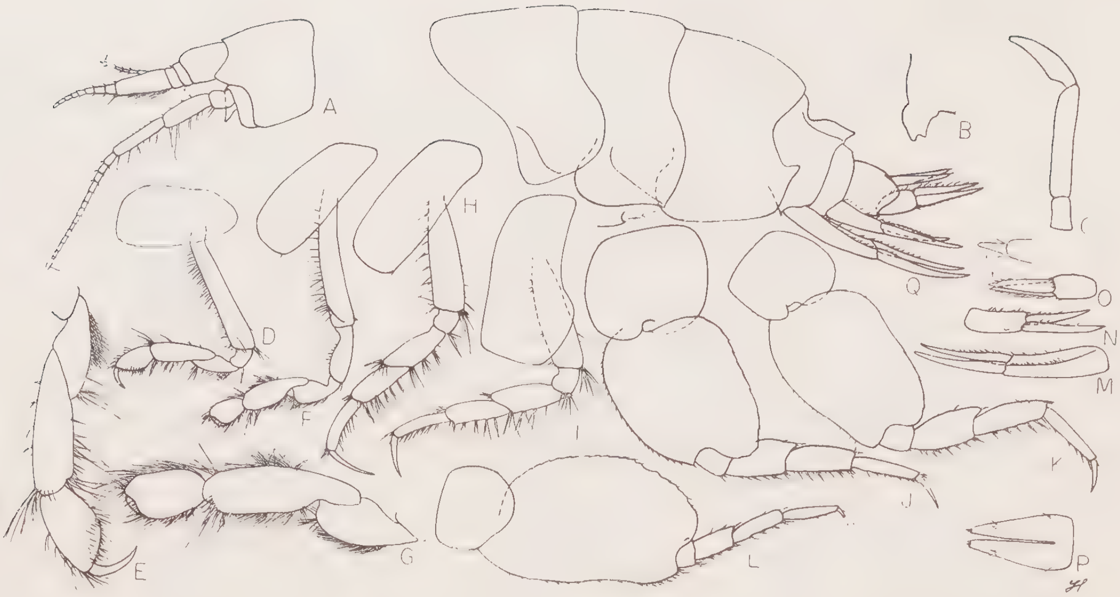


Fig. 9. *Hippomedon antitemplado* n.sp. Female, holotype, 15 mm, St. 601. A, head; B, epistome and upper lip; C, palp of mandible; D, E, gnathopod 1; F, G, gnathopod 2; H, I, J, K, L, pereopods 1, 2, 3, 4, 5; M, N, O, uropods 1, 2, 3; P, telson; Q, pleon.

Hippomedon concolor n. sp.

(Fig. 10)

Material:

St. 607, Tasman Sea, 44°18'S, 166°46'E, 3580 m, clay, HOT, 17. I. 1952. Holotype, female, 11 mm. Unique.

Generic assignment:

The unique specimen lacks pleon segment 6 and most of uropods 1 and 2. Even if these were present the species would be difficult to assign to a genus. By assuming the telson would be entire the species would fit into none of the known genera on the basis of mouthparts and gnathopods. By assuming the species to have a telson split half its length the species might be placed in *Paratryphosites,* a genus essentially monotypic since *P. minusculus* Gurjanova probably has been misassigned to that genus. There are so many other minor features of possible generic difference in mouthparts that it is not possible to accept the assignment of *H. concolor* to *Paratryphosites.* The only remaining alternative is to assume that the telson would be fully cleft. The condition of the first gnathopod causes difficulty in keys for articles 5 and 6 are so much the same length. If the species were assigned to *Tryphosa* it would be unique in the very oblique palm on the expanded sixth article of gnathopod 1. On the other hand if assigned to *Hippomedon,* it would differ in the equal lengths of the fifth and sixth first gnathopodal articles, whereas most Hippomedons have the fifth article greatly longer than the sixth. Indeed the general shape of article 6 and especially the similarity of the third pleonal epimeron to many Hippomedons are the features which have been relied on.

Diagnosis:

Eyes absent; lateral head lobes conical, apices not sharply acute; first article of antenna 1 slightly swollen and produced apically; fifth and sixth article of gnathopod 1 subequal in length, palm distinct, longer than hind margin of article 6; epistome and lower lip nearly straight in front; lower hind edge of article 2 on pereopod 5 excavated slightly (not damaged, condition identical on both sides of animal); lower edge of second pleon epimeron sinuate (both sides), third pleonal epimeron with thick posterior tooth which is attenuated and sharply acute distally; pleon segment 4 with dorsal erect, subacute keel; coxae 1-2 with a microscopic notch at each lower posterior corner.

Relationship:

This species is most closely related to the preceding *H. antitemplado* n. sp. The resemblance is remarkable at first sight; unless various parts are mounted flat or turned into comparable positions the two species might be confused easily. *H. antitemplado* bears the tendencies of many characters which show their full expression in *H. concolor,*

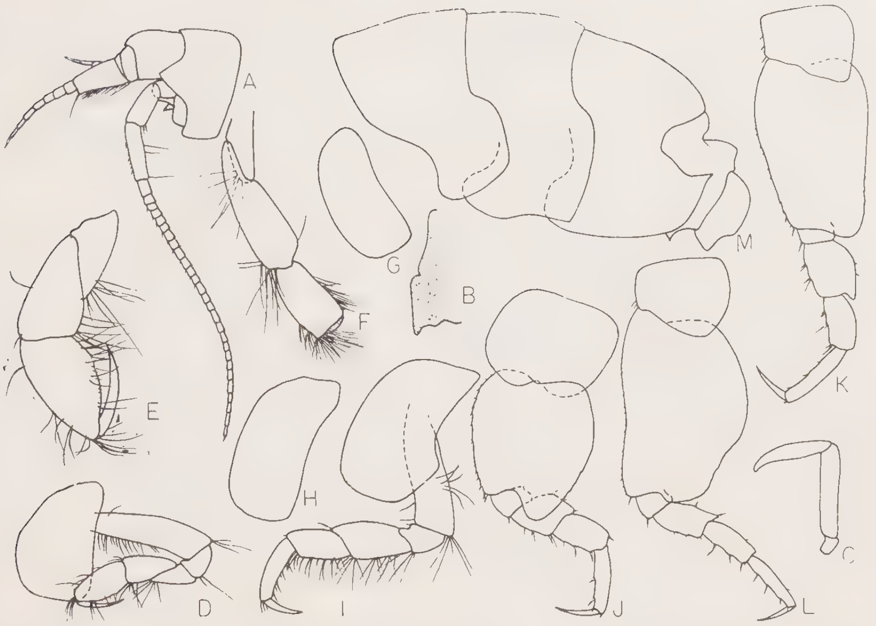


Fig. 10. *Hippomedon concolor* n. sp. Female, holotype, 11 mm, St. 607. A, head; B, epistome and upper lip; C, palp of mandible; D, E, gnathopod 1; F, gnathopod 2; G, H, coxae 2, 3; I, J, K, L, pereopods 2, 3, 4, 5; M, pleon, last segment missing, uropods broken.

such as the sinuate lower edge of the second pleonal epimeron, the distal swelling of the first antennal article, the shape of the mandibular palp and the third pleonal epimeron and the relatively uncommon possession of a dorsal crest on pleon segment 4. Holotypes of each species are females so that no sexual differences are involved. Undoubted differences of specific value exist in the first gnathopod as so diagnosed and figured; a comparison of the figures of the second gnathopods shows that one species has an oblique, the other a transverse palm; *H. antitemplado* bears lateral ridges on the first and second pleonal epimera, not seen on *H. concolor*. Except that *H. concolor* bears a distally modified first article on the first antenna, it differs from other relatives in the genus by the same factors stated for *H. antitemplado*.

Hippomedon tasmanicus n. sp.

(Fig. 11)

Material:

St. 601, Tasman Sea, 45°51′S 164°32′E, 4400 m, Globigerina ooze, HOT, 14. I. 1952. Holotype, ovigerous female, 17 mm; one male fragment, with antennae bearing calceoli. Total: 2 specimens.

Diagnosis:

Eyes absent, lateral lobes of head acutely produced; peduncular articles of first antenna not dentiform; third pleonal epimeron with small acute tooth, not incised; pleon segment 4 bearing a dorsal incision, followed by a low, smooth hump; article 6 of gnathopod 1 with a distinct palm but not inflated, article 6 about two thirds as long as 5; epistome not produced, formed into a broad, flat lamina; coxae 1-3 each with a minute distal posterior notch.

The mouthparts are like *Hippomedon denticulatus* (in Sars 1895: pl. 20) except for the first maxillary inner plate which is rather setose, bearing 9 setae; the mandible has 2 spines in the spine row. The gills of pereopods 5 and 6 each bear one slender accessory lobe.

Relationship:

The genus *Hippomedon* had 24 species (J. L. Barnard 1958), but the taxonomic characters are rather subtle, largely proportional and have not been studied in relation to growth stages or intraspecific variations. Two principal shapes of third pleonal epimeron occur (apart from *H. bidentatus* and *H. striolatus)* which have the lower tooth slender and evenly tapering or with the lower edge of the tooth broadly inflated to form a stout tooth with all of the tapering occurring only on the lower edge. Occasionally, in the latter type the dorsal base of the tooth may bear an incising notch. The recognition of these types, considering intergradation, is a subjective ability and requires visual compari-

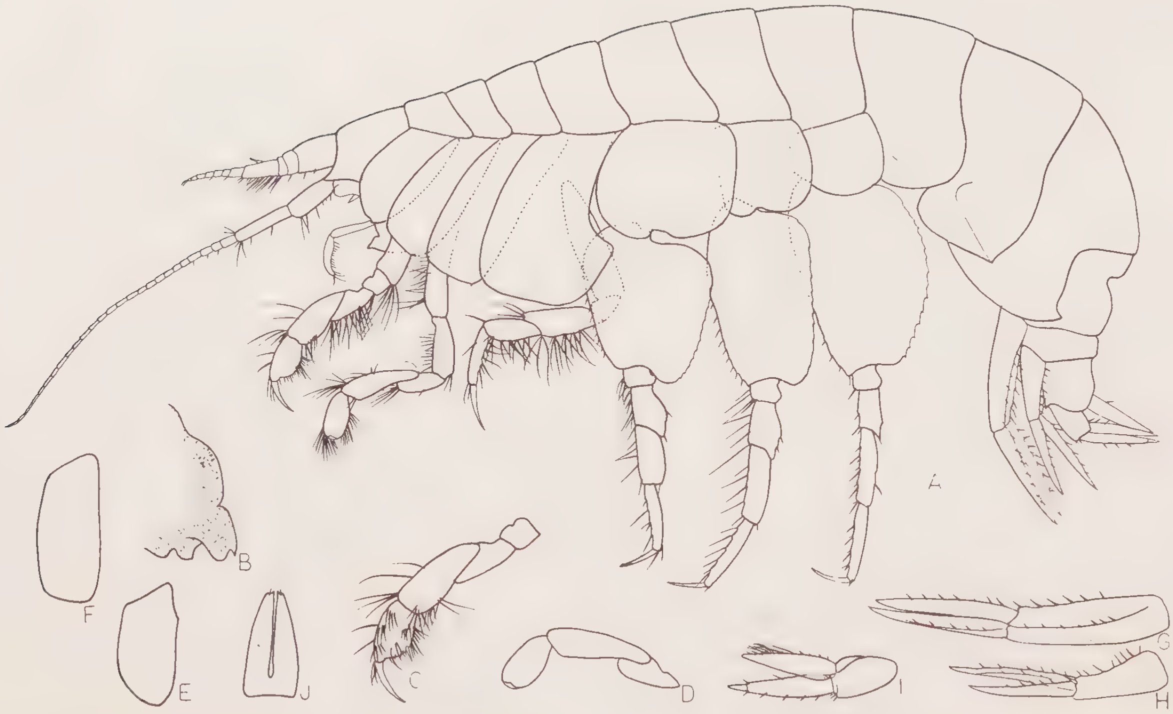


Fig. 11. *Hippomedon tasmanicus* n. sp. Female, holotype, 17 mm, St. 601. A, lateral view; B, epistome and upper lip; C, D, gnathopods 1, 2; E, F, coxae 1, 2; G, H, I, uropods 1, 2, 3; J, telson.

son, not written statements. It may prove that juvenile animals pass through stages of slender epimeral teeth and lack of notches before the stage of stout teeth and presence of notches is reached, which will necessitate realignment of the species when life histories are studied. For instance, *H. propinquus* may be the young of *H. denticulatus* (see Sars 1895: pls. 20 and 21), for even the projections on the first antennal peduncle may be products of advanced age.

The distinctive features of *H. tasmanicus* are the very acute lateral head lobes, the small tooth of the third pleonal epimeron and the lack of a carina on pleon segment 4. Three other species bear close relationship but *H. tasmanicus* differs from each as follows: from *H. geelongi* Stebbing, 1888 (pl. 11), by the relatively shorter sixth article of the first gnathopod and the shorter tooth of the third pleonal epimeron; from *H. longimanus* (Stebbing, 1888: pl. 13) by the lack of a carina on pleon segment 4 and contrasting shape of the sixth article on gnathopod 2; from *H. bandae* Pirlot, 1933 (p. 144) by the shape of the head, although Pirlot's fig. 50 suggests that the head was crushed in mounting; by the slightly better developed tooth of the third pleonal epimeron and the distinct palm of gnathopod 1, whereas in *H. bandae* article 6 of gnathopod 1 is quite inflated.

Onesimoides Stebbing

Key to Onesimoides

1. Palm of gnathopod 1 transverse, entire 2
1. Palm of gnathopod 1 oblique, sinuate 3
2. Back slightly carinate; article 6 of gnathopod 1 moderately stout, palm not chelate .... *carinatus*
2. Back not carinate; article 6 of gnathopod 1 slender, palm slightly chelate....... *chelatus*, female
3. Article 6 of first gnathopod 1.5 times as long as broad, palm oblique; pleon segment 4 with dorsal carina .... *cavimanus*
3. Article 6 of first gnathopod slightly more than twice as long as broad, palm parallel to hind margin; pleon segment 4 lacking dorsal carina.. *chelatus*, male

Onesimoides chelatus Pirlot, 1933
(Figs. 12, 13, 14 and Photogr. 1)

Onesimoides chelatus Pirlot, 1933: 134-139, figs. 43-45.

Material:

St. 52, San Tomé-Cameroon, 1°42′N 7°51′E, 2550 m, muddy clay, SOT, 30. XI. 1950. Male, 15 mm, figured.

St. 450, Celebes Sea, 1°50′N, 119°20′E, 4940-4970 m, HOT, 21. VIII. 1951. In *Nipa*-palm fruit, first fruit with 2 males (first gnathopods figured), 4 females, 11 juveniles and 3 fragments; second fruit with 58 specimens. The animals had entered the nut via the micropyle which may have been eaten out.

St. 453, Makassar Strait, 3°56′S 118°26′E, 2000 m, greenish clay, ST 300, 24. VIII. 1951. Female, figured, 8.5 mm; female, ovigerous, 9 mm; ?sex 4.5 mm. Total: 3 specimens.

Diagnosis of male:

Article 6 of gnathopod 1 more than twice as long as broad, palm very oblique, nearly parallel with hind edge of article 6 but excavated and defined from the hind margin; palm about half as long as rest of hind margin, article 7 recurved, fitting palm; pleon segment 4 dorsally smooth, not carinate.

Remarks:

Two peculiarities are concerned with this species. First, the male and the female differ remarkably in their first gnathopods, a feature unique to the large family Lysianassidae. There appears to be no doubt that the two forms represent the same species, for they have been captured together inside a palm fruit from St. 450. The first gnathopods of the females are small, slender and slightly chelate, while those of the males are large, stout and not chelate, but the palm is oblique and excavated. The first gnathopods of the only 2 males associated with females in the coconut are figured to show two of the steps between the slender female-like gnathopod and the stout male-like gnathopod. The full male is figured from a specimen collected in the tropical eastern Atlantic ocean. It is a larger specimen and had gnathopod 1 more fully developed than in the Celebes males, but no other systematic differences could be detected. For this reason, the second peculiarity is the wide distribution of a benthic, abyssal species, known now from the Atlantic and the southwest Pacific, but it is feasible that such a wide distribution might be accounted for by the fact that

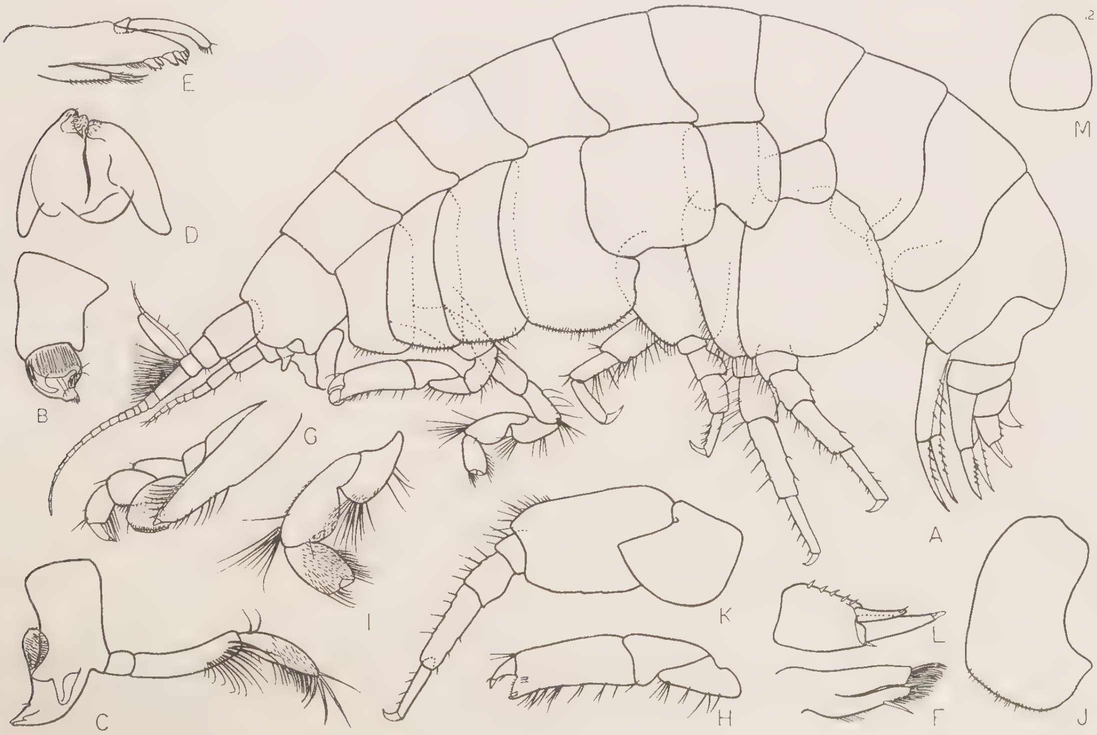


Fig. 12. *Onesimoides chelatus* Pirlot. Female, 8.5 mm, St. 453. A, lateral view; B, upper lip, posterior view; C, mandible; D, lower lip; E, F, maxillae 1, 2; G, maxilliped; H, I, gnathopods 1, 2; J, coxa 4; K, pereopod 4; L, uropod 3; M, telson.

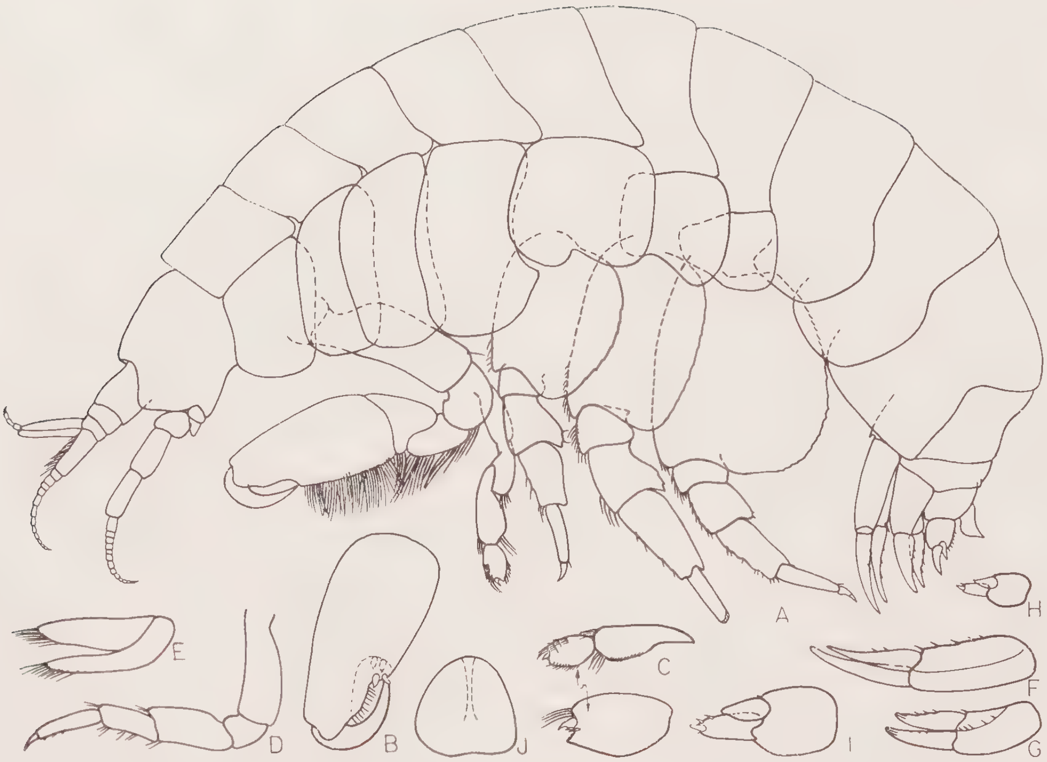


Fig. 13. *Onesimoides chelatus* Pirlot. Male, 15 mm, St. 52. A, lateral view; B, C, gnathopods 1, 2; D, pereopod 1; E, maxilla 2; F, G, H, uropods 1, 2, 3; I, uropod 3, enlarged; J, telson.

the species feeds on woody debris. The oily body of the large 15 mm male suggests that the species may be demersal and attack submerged waterlogged wood before it reaches bottom so that the animals might be transported long distances before the wood finally settles. On the other hand the species feeds on oily food such as coconut meat and its oiliness may have no connection with its ability to swim.

It will prove interesting to discover the females of the other two species of *Onesimoides,* which are distinguished in the preceding key, now that the male-female relationship of *O. chelatus* has been worked out.

Food:

According to Pirlot (1933) this species eats wood. The 9 mm female of St. 453 was dissected and the stomach found to be filled with a peculiar unidentifiable material, red in color, appearing like rumpled sheets of chitin, some as large as 0.2 mm across and clumps of reddish fine particulate detritus. The small 4.5 mm specimen of St. 453 was dissected and its gut filled with the same kind of red detritus.

The stomach of the male of St. 52 contained much finely particulate organic matter, with a few small mineral grains. The body was exceedingly oily. The stomach contents of a female from St. 450 were examined in comparison with scrapings of the coconut-like meat on which the amphipods were feeding and found to be identical in composition, being composed of highly refractile fibrous material.

Distribution:

Neighbourhood of the Celebes Sea, 4940 m, on the east sill of the basin at 2053 m, on the southwest sill of the basin in Makassar Strait, 2000 m and in the Moluccas Passage, 1264-1165 m; Gulf of Guinea, 2550 m.

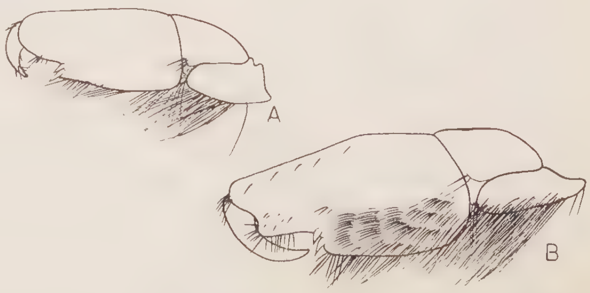
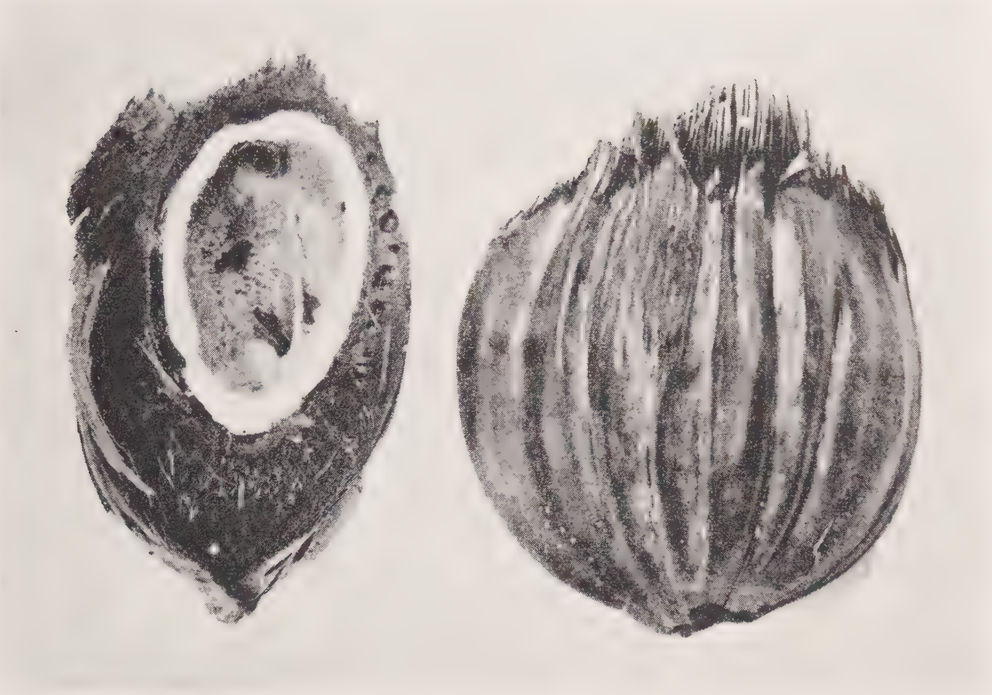


Fig. 14. *Onesimoides chelatus* Pirlot. First gnathopods, medial views, St. 555. A, male, 7 mm; B, male, 8 mm.



Photograph No. 1. Fruits of *Nipa*-palm at St. 450, dredged from 4940-4970 m in the Celebes Sea, containing 76 specimens of *Onesimoides chelatus* Pirlot which had entered the nuts through the micropyle and were eating the soft meat. The fruit on the left has been split open. Magnification, × $^{1}/_{2}$.

Orchomene ? takoradia n. sp.

(Fig. 15)

Material:

St. 30, Monrovia-Takoradi, 0°42′N 5°59′W, 5160 m, clay, ST 300, 18. XI. 1950. Holotype, female, 16 mm.

Diagnosis:

Eyes absent; lateral lobes of head very broad and rounded; antennae remarkably short; epistome slightly exceeding upper lip in front; mandible with distinctly ridged and toothed, but small molar, palp stout; mandibular lobes of lower lip stout; maxillae strongly styliform; inner lobes of second maxillae short, stout, unarmed, outer lobes very slender, armed apically with 3 spines; inner lobes of maxilla 2 much shortened, slender, not setose on inner edge, apex with one seta; article 4 of maxilliped short, not evenly claw-like (see figure); palm of gnathopod 1 with 3 small, sharp cusps; gnathopod 2 not minutely chelate, lacking palm, article 7 long, overlapping distal end; third pleonal epimeron rounded behind, dorsal surface of pleon segment 4 raised into a slight but massive boss; inner ramus of uropod 3 distinctly smaller than outer ramus; telson cleft nearly half its length.

Generic position:

It is questionable whether this species belongs to the genus *Orchomene* or any of its close relatives and it probably should form the type of a new genus. Although some species of the genus *Orchomene* show tendencies to bear characters of this new species, the special combination of them is unique. Particularly important is the shape of the second gnathopod, which in all other Orchomenes is minutely chelate. The shortened inner lobe of the second maxilla, the shape of maxilla 1 and maxillipedal palp article 4 also are certainly of generic importance. Nevertheless the writer hesitates to erect a new genus, until more abyssal orchomenids are discovered and possible intergrades described.

Orchomenella cavimanus (Stebbing, 1888), var.

(Fig. 16)

Orchomene cavimanus Stebbing, 1888: 679, pl. 22.

Orchomenella cavimanus, SCHELLENBERG 1926a: 285-287, fig. 25; K. H. BARNARD 1932: 69, fig. 27g.

Orchomenopsis excavata Chevreux, 1903: 94-96, fig. 7.

Orchomenopsis chevreuxi Stebbing, 1906: 721; CHEVREUX 1935: 60-62, pl. 16, fig. 15.

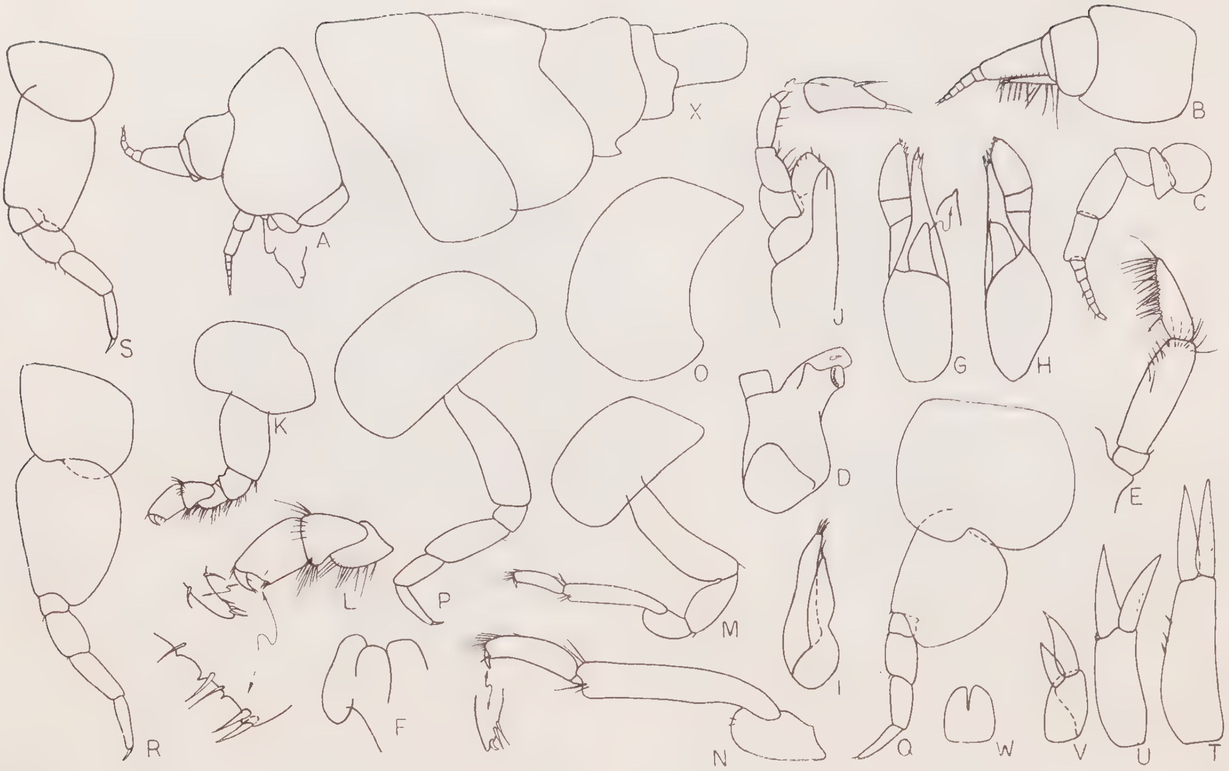


Fig. 15. *Orchomene takoradia* n.sp. Holotype, female, 16 mm, St. 30. A, head; B, C, antennae 1, 2; D, mandible; E, mandibular palp; F, lower lip, part; G, H, maxilla 1; I, maxilla 2; J, maxilliped; K, L, gnathopod 1; M, N, gnathopod 2; O, coxa 4; P, Q, R, S, pereopods 1, 3, 4, 5; T, U, V, uropods 1, 2, 3; W, telson; X, pleon segments 2-6.

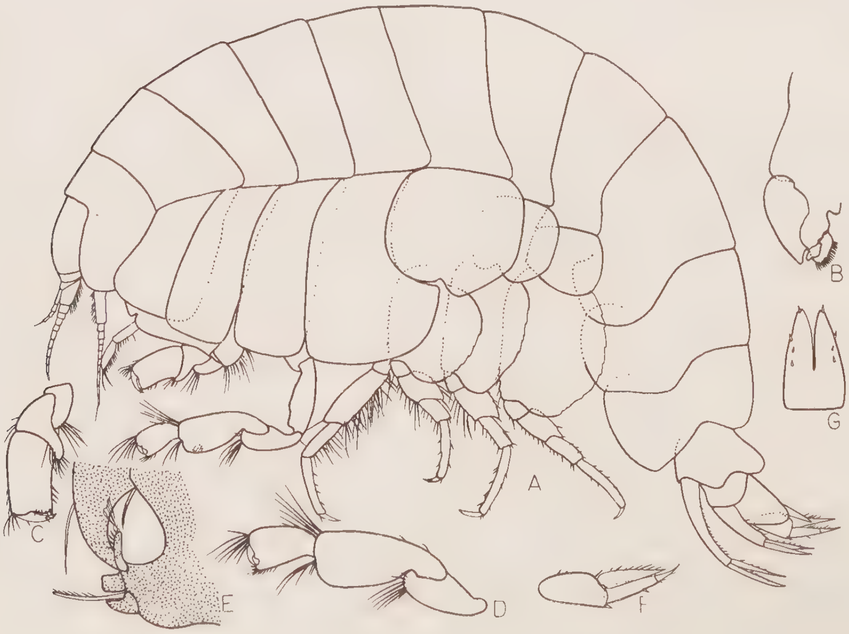


Fig. 16. *Orchomenella cavimanus* (Stebbing). Male, 10 mm, St. 607. A, lateral view; B, upper lip and epistome; C, D, gnathopods 1, 2; E, enlarged end of gnathopod 2; F, uropod 3; G, telson.

Material:

St. 575, Tasman Sea, 40°11′S 163°35′E, 3710 m, pteropod ooze, SOT, 19. XII. 1951. Female, 14 mm.

St. 607, Tasman Sea, 44°18′S 166°46′E, 3580 m, clay, HOT, 17. 1. 1952. Male, 10 mm, figured.

Diagnosis of new material:

Eyes absent; epistome straight in front, not produced; article 6 scarcely narrowing distally, article 5 short, with slender posterior lobe; article 6 of gnathopod 2 moderately stout, not narrowing distally, with concave palm, two stout spines and a complex defining ridge, article 7 well developed; third pleonal epimeron with straight posterior edge, lower corner rounded or subquadrate; pleon segment 4 with large dorsal hump; telson split slightly more than halfway.

Mouthparts like *O. abyssorum* (Stebbing, 1888: pl. 21) but palp article 3 of the mandible is less expanded proximally and maxilla 2 is like *O. musculosa* (Stebbing, 1888: pl. 20).

Remarks:

The specimens referred to in the above synonymy all have slight differences assorted among them which do not justify specific segregation but do require provisional varietal and subspecific designations, as discussed below.

In the original description of the species STEBBING (1888) did not show the peculiar process on the palm of gnathopod 2, but SCHELLENBERG (1926) did, although the fourth pleonal segment in his figure differed slightly from that on STEBBING's figure. CHEVREUX (1903) showed a slightly different interpretation of gnathopod 2 and probably overlooked the distinctness of the process for it is likely to be confused with a piece of dirt and is partly hidden by the finger. His fourth pleonal segment differed from both STEBBING's and SCHELLENBERG's figures. The material at hand exhibits still another slight difference in the fourth pleonal segment but has the process of gnathopod 2 as shown by SCHELLENBERG. The second maxillary plates on STEBBING's figure were subequal in size, but on CHEVREUX's and the present specimen they are very unequal. K. H. BARNARD (1932) showed an even more triangular and pointed process on pleon segment 4.

The specimen at hand has no eyes and only a slight trace of brownish pigment. The species differs from *O. abyssorum* (Stebbing, 1888) by the nonchelateness of gnathopod 2 and from the general conception of *O. chilensis* (Heller) and *O. musculosa* (Stebbing, 1888) by the expanding sixth article and concave palm of gnathopod 2.

Gut contents:

The stomach of this animal contained a small amount of material, of which about 90 % were silt particles, indicating that it feeds on the bottom. Its capture by previous expeditions at the surface, in pelagic tows, indicates its demersal habit.

Distribution:

Widely distributed by scattered records through the north and south Atlantic Oceans, the southern Indian Ocean and Antarctica, from the surface in the Antartic, Falklands and South Georgia to 228 m at Kerguelen and 3970 and 4360 m in the middle and north Atlantic. Recorded here from the Tasman Sea, 3580 m.

Orchomenella musculosa (Stebbing, 1888)
(Fig. 17)

Orchomene musculosus Stebbing, 1888: 673, pl. 20.

Material:

St. 183, off Simonstown, Durban, South Africa, 33°25′S 37°20′E, 5210 m, S 200C, E.F.D. 3000-3600 m, 28. I. 1951. 1 specimen, 8 mm.

Remarks:

Since K. H. BARNARD (1925) reduced this species to *O. chilensis* it has remained a synonym and was so considered by SCHELLENBERG (1926a). SCHELLENBERG combined under *O. chilensis* a large number of synonyms many of which have been reinstated as valid species since, especially by K. H. BARNARD (1932). I am still unclear as to precisely what *O. chilensis* is because I lack HELLER's (1865) original description. However, *O. musculosa* as described by STEBBING differs from all the other species which have ever been considered to belong to *O. chilensis*, in one way or another. It is my opinion that most of these species should remain valid, for each has minor but distinct differences which point to possible differences in habitat. It is probable that this closely allied group of Orchomenellas is pelagic, since many have been caught exclusively in plankton hauls or in surface nets, just as the present material. It is possible that water-mass subspecies are involved, with a range through considerable depths. Studies on the problem will not be stimulated by

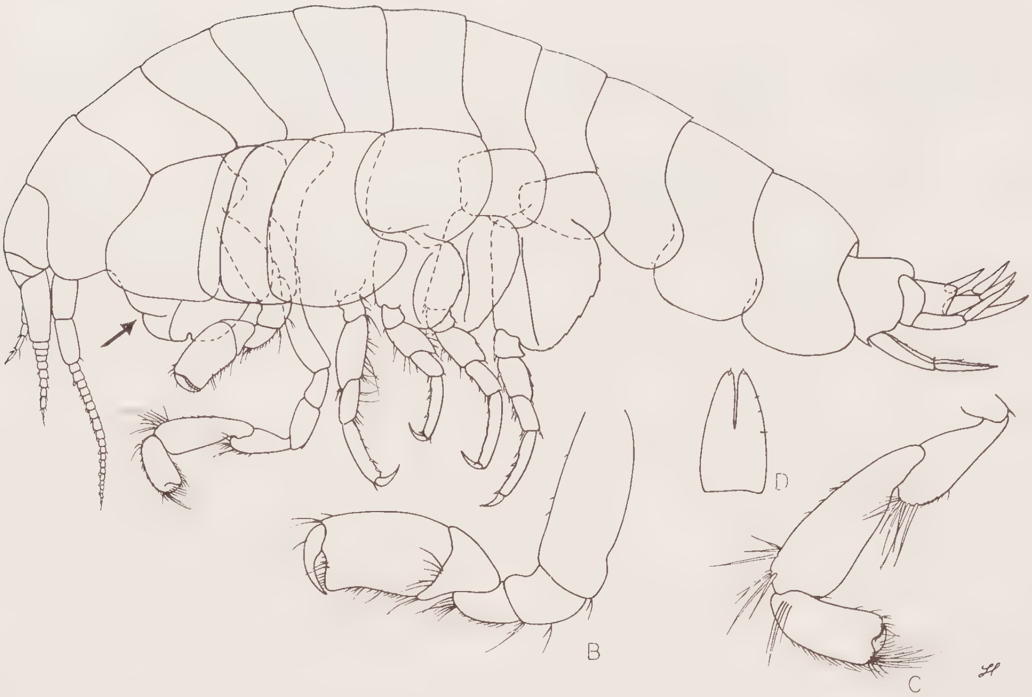


Fig. 17. *Orchomenella musculosa* (Stebbing). Specimen, 8 mm, St. 183. A, lateral view, arrow indicates epistome and upper lip; B, C, gnathopods 1, 2; D, telson.

fusing all of the species as has Schellenberg; K. H. Barnard (1932) is right in keeping them separated.

The present species or the precise form of it has not been captured according to the literature since its original description from the North Pacific. That it occurs off South Africa is of considerable interest in affirming that it is bathypelagic although it implies that the "chilensis"group of species is simply a variable genosome distributed in cosmopolitan fashion.

However, the writer is unable to accept the fusion of species which have such obvious differences as the chelateness or nonchelateness of the second gnathopods, which *O. musculosa* has in the negative. In this respect the species is most closely related to *O. proxima* Chevreux (Chevreux, 1903) which was fused to *O. chilensis* by Schellenberg (1926a), K. H. Barnard (1925) and affirmed by Shoemaker (1945a). In his original description Chevreux made a point of distinguishing *O. proxima* from *O. musculosa* and I believe his distinctions should stand. The telson is slightly less split in *O. musculosa*, the second gnathopod has a much larger, longer dactylus and the sixth article is more elongate and rectangular whereas in *O. proxima* it is stouter and more quadrangular. Whether *O. proxima* is indeed *O. chilensis* cannot be answered but *O. musculosa* certainly differs from *O. proxima* and conceptions of *O. chilensis* by various authors.

O. musculosa differs from *O. abyssalis* Stephensen, 1925 by the shorter and more lobate article 5 of gnathopod 1.

The mouthparts fit the figures of Stebbing (1888) precisely.

Paronesimoides lignivorus Pirlot, 1933

Paronesimoides lignivorus Pirlot, 1933: 140-143, figs. 46-48.

Material:

St. 453, Makassar Strait, 3°56′S 118°26′E, 2000 m, greenish clay, ST 300, 24. VIII. 1951. Specimen 5 mm and one rear end. Total: 2 specimens.

Distribution:

Pirlot stated that this species eats wood; therefore it must be benthic. Confined to the Celebes Sea basin, on the east sill (Pirlot) at 2053 m and on the southwest sill in Makassar Strait at 2000 m. Its distribution may prove to follow that of *Onesimoides chelatus*, with which it is associated.

Procyphocaris n. gen.

Diagnosis:

Head short but not deformed, with well developed lateral lobes; coxae 1 and 2 small, largely hidden by coxa 3; both pairs of gnathopods slightly subchelate; coxa 5 very large; pereopod 3 not indentured; mandible with well developed palp and ridged molar; accessory flagellum with 3 articles; pereopods not prehensile; uropod 3 with subequal rami; telson long and deeply cleft.

Type species: *Procyphocaris primata,* n. sp.

Relationship:

This is the least specialized genus so far described in the cyphocarid series of Lysianassidae. A progressive order of specialization is seen in the following scheme, where the genera are listed and the points of difference from *Procyphocaris* stated.

1. *Procyphocaris* n. gen. Mandible with palp and well developed molar ridges; head not deformed, lateral lobes well developed.

2. *Cyphocaris* Boeck. Mandibular molar ridged but the second article of pereopod 3 is deeply indentured and the head lacks lateral lobes or is badly deformed. All of the following genera also have heads modified as in *Cyphocaris.*

3. *Cyclocaris* Stebbing. The molar is thin and unridged (some published figures omit the molar); the chisel teeth are lost from outer plate of the maxilliped.

4. *Lepidepecreella* Schellenberg. Mandibular molar evanescent, chisel teeth of maxilliped lost as in all following genera, inner ramus of uropod 3 reduced.

5. *Mesocyphocaris* Birstein and Vinogradov. Mandibular molar absent, as in all following genera, inner ramus of uropod 3 reduced, pereopods prehensile.

6. *Paracyphocaris* Chevreux. First four pairs of pereopods are slightly to strongly prehensile, rami of uropod 3 subequal.

7. *Metacyclocaris* Birstein and Vinogradov. About in the same stage as the previous genus but all five pairs of pereopods are prehensile and the mandibular palp is better developed.

8. *Crybelocyphocaris* Shoemaker. Mandibular molar absent; accessory flagellum lost; inner ramus of uropod 3 small; pereopods 1 and 2 are slightly prehensile and urosome segments 2 and 3 are fused.

9. *Metacyphocaris* Tattersall. In addition to the absence of mandibular molar the palp has been lost; uropod 3 has a small inner ramus; the accessory flagellum is uniarticulate; pereopods 1-3 are prehensile.

10. *Crybelocephalus* Tattersall. Both the palp and the molar of the mandible are absent; the accessory flagellum is absent; pereopods 1 and 2 are prehensile.

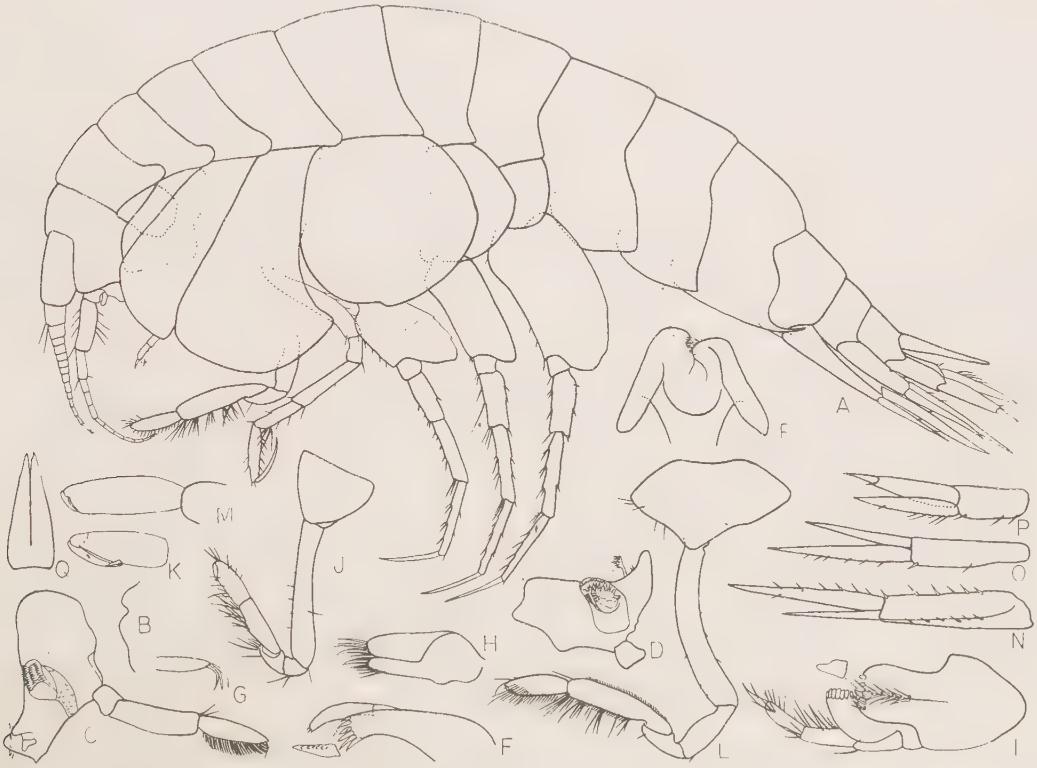


Fig. 18. *Procyphocaris primata* n. gen., n. sp. Female, holotype, 8 mm, St. 554. A, lateral view; B, epistome and upper lip; C, D, mandibles; E, lower lip; F, H, maxillae 1, 2; G, inner plate of maxilla 1; I, maxilliped; J, K, gnathopod 1; L, M, gnathopod 2; N, O, P, uropods 1, 2, 3; Q, telson.

Procyphocaris primata n. sp.
(Fig. 18)

Material:

St. 554, Great Australian Bight, 37°28′S 138°55′E, 1340-1320 m, Globigerina ooze, ST 300, 5. XII. 1951. Holotype, female, 8 mm. Unique.

Diagnosis:

With the characters of the genus.

The third pleonal epimeron has a long tooth, which is unique in the cyphocarid genera.

Pseudonesimus Chevreux, 1926

Pseudonesimus Chevreux, 1926: 3.

One of the more characteristic features of this genus is the shortened first coxa, not included by CHEVREUX in his diagnosis.

Pseudonesimus abyssi tasmanensis n. subsp.
(Fig. 19)

Pseudonesimus abyssi Chevreux, 1926: 3-5, fig. 2.

Material:

St. 601, Tasman Sea, 45°51′S 164°32′E, 4400 m, Globigerina ooze, HOT, 14. I. 1952. Holotype, female, 10 mm. Unique.

Diagnosis:

Differing from the typical subspecies known from the Gascogne Gulf, northeastern Atlantic Ocean, 4380 m, by the slight tooth developed at the lower corner of the third pleonal epimeron and the slightly more slender fifth and sixth articles of the first gnathopod. The apices of the lower lip are not as strongly incised as in the typical subspecies.

Remarks:

Because only two specimens of this specific complex are known, each from nearly opposite extremes of the Earth, the variation within a population is unknown and the distinctive features of the new subspecies may be little more than variations. The species is probably abyssally pelagic, rather than benthic, considering its wide range.

cf **Tmetonyx caeculus** (Sars, 1895)

Hoplonyx caeculus Sars, 1895: 98, pl. 35, fig. 1.
Tmetonyx caeculus, STEBBING 1906: 76-77.

Material:

St. 241, off Kenya, 4°00′S 41°27′E, 1510 m, Globigerina ooze, HOT, 15. III. 1951. 1 juv. 3 mm.

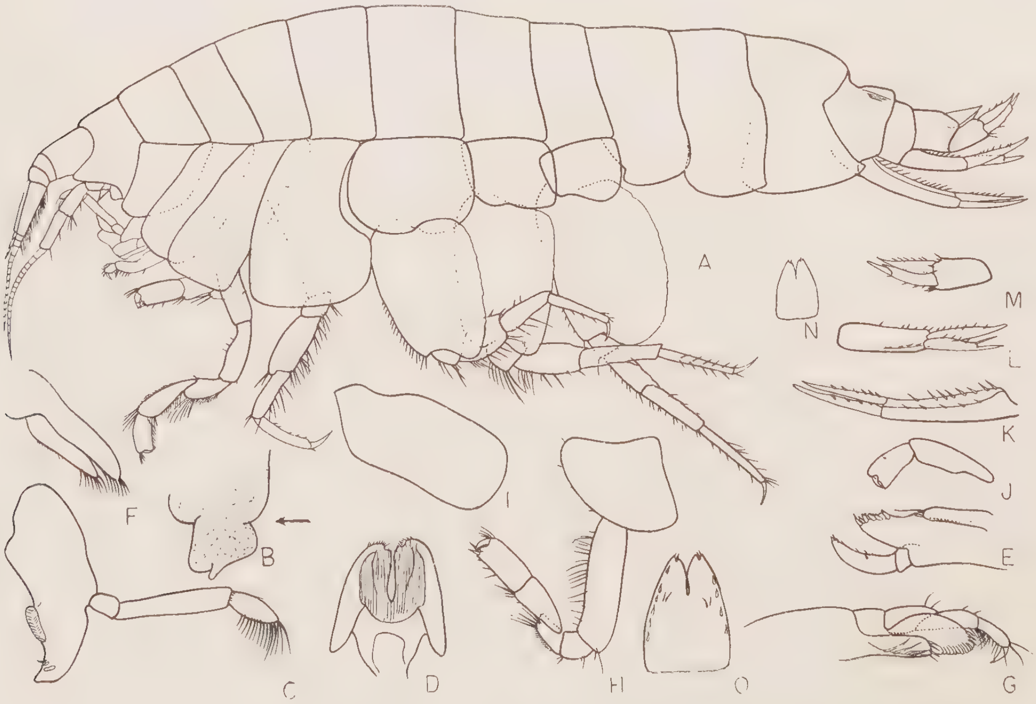


Fig. 19. *Pseudonesimus abyssi tasmanensis* n. subsp. Female, holotype, 10 mm, St. 601. A, lateral view; B, epistome and upper lip, arrow indicating front; C, mandible; D, lower lip; E, F, maxillae 1, 2; G, maxilliped; H, J, gnathopods 1, 2; I, coxa 2; K, L, M, uropods 1, 2, 3; N, O, telson.

Distribution:

Northeastern Atlantic Ocean: Barents Sea; 150-600 m; recorded here from the western Indian Ocean.

Remarks:

The present juvenile specimen of 3 mm length is very like *T. caeculus* as figured by Sars, differing only by the slightly more prolonged tooth of the third pleonal epimeron. Without accompanying adults I am unable to confirm the identification and do not wish to dissect the animal without additional materials.

Trischizostoma Boeck, 1861

Several problems concerning this genus remain unanswered. Some of these were discussed by Stebbing (1908: 59-61) but since that time several more have arisen.

Members of the genus obviously are semiparasitic, because of the piercing mouthparts. It is well known that parasites often are polymorphic and this fact must be kept in mind.

Including the new species to be described, two distinct groups, each representing 3 species, have been described. Each group shows remarkable contrasts in mouthparts, telson and head.

Nicaeense-Longirostre-Circulare group: Rostrum very large, conspicuous; mouthparts, including upper lip, mandibles and maxillae are strongly styliform; telson entire.

Remipes-Paucispinosum-Serratum group: Rostrum small, deflexed, inconspicuous; mouthparts much less styliform; telson cleft to middle.

The writer believes that these differences warrant separate genera. If, indeed, the two groups are congeneric then at least in the *Nicaeense* group the three species should be considered closely related subspecies. Had it not been for Stephensen's description of *T. longirostre* as a full species the writer would have considered the new species to follow to be a subspecies of *T. nicaeense*. The problem requires statistical study with large amounts of material.

Key to Trischizostoma

1. Gnathopod 1, inner margin of article 7 bearing denticles	*serratum*
1. Gnathopod 1, inner margin of article 7 smooth	2
2. Telson cleft to middle, rostrum inconspicuous	3
2. Telson entire, rostrum long	4
3. Palm of first gnathopod very spinose	*remipes*
3. Palm of first gnathopod scarcely spinose	*paucispinosum*
4. Article 6 of first gnathopod triangular	*nicaeense*
4. Article 6 of first gnathopod oval	*longirostre*
4. Article 6 of first gnathopod circular	*circulare* n. sp.

Trischizostoma circulare n. sp.

(Fig. 20)

Material:

St. 203, off Natal, 25°36′S 35°21′E, 730 m, HOT, 21. II. 1951. Holotype, male, 24 mm; another damaged specimen 21 mm. Total: 2 specimens. Field color notes: bodies white, eyes dark brown, back with faintly rose longitudinal stripes.

Diagnosis:

Article 6 of gnathopod 1 nearly circular, article 7 with smooth inner margin; telson entire; rostrum long; article 6 of gnathopod 2 asymmetrical, distal end produced.

Relationship:

See the key and previous discussion for general group relationships. The species differs from *T. longirostre* Stephensen (Stephensen 1927: pl. 1) by the shape of the sixth article on gnathopod 2. In other respects it is like *T. nicaeense* (in Sars 1895: pl. 12) except for the circular sixth article of gnathopod 1. The mouthparts are similar to those of the latter species except for the upper and lower lips which are figured herein, and the second coxa which is broadly rounded in front, not subacute. The gills are strongly pleated.

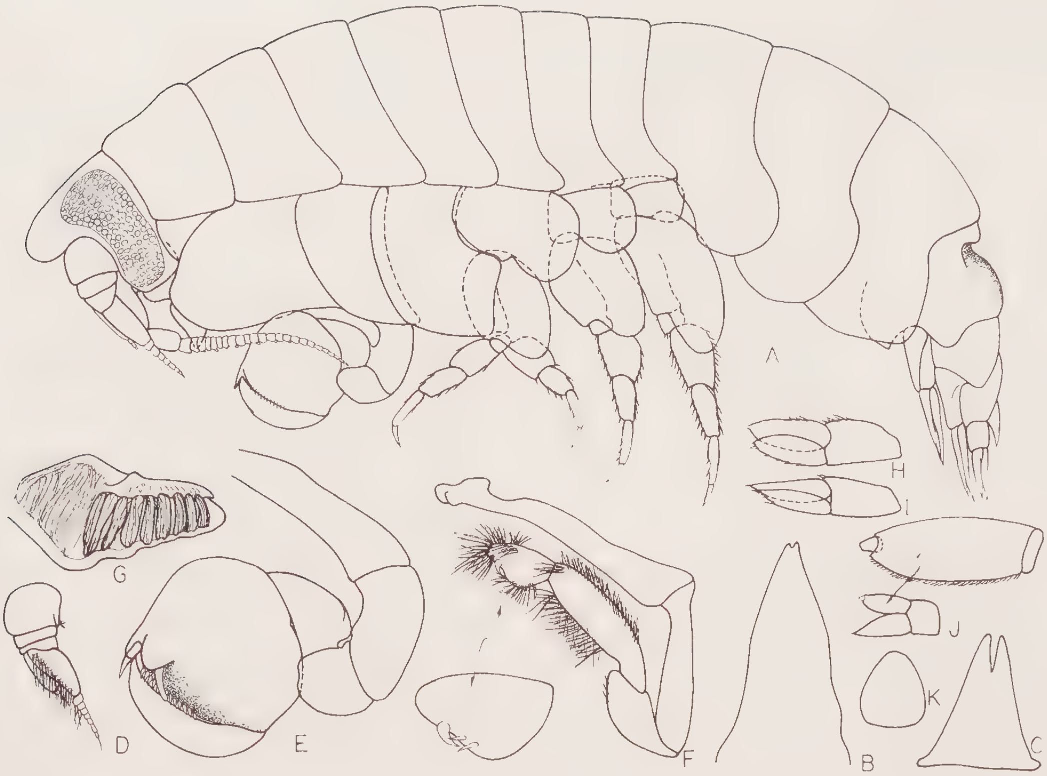


Fig. 20. *Trischizostoma circulare* n.sp. Male, holotype, 24 mm, St. 203. A, lateral view; B, C, upper and lower lips; D, antenna 1; E, F, gnathopods 1, 2; G, gill; H, I, J, uropods 1, 2, 3; K, telson.

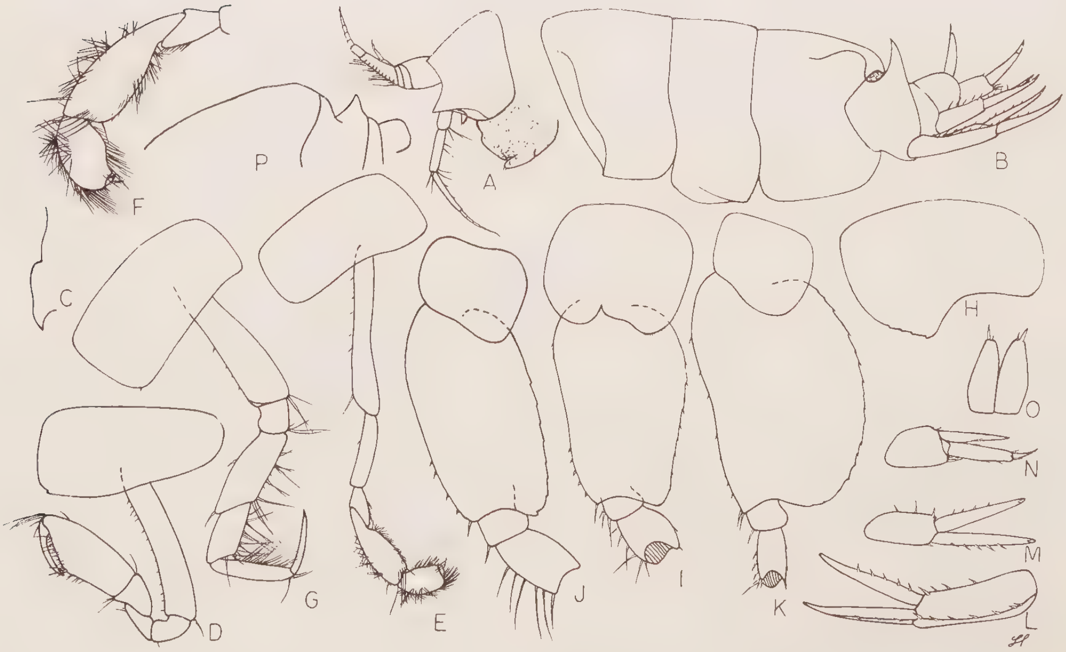


Fig. 21. *Uristes cansada* n. sp. Female, holotype, 7 mm, St. 626. A, head; B, pleon; C, epistome; D, E, gnathopods 1, 2; F, gnathopod 2, enlarged; G, I, J, K, pereopods 1, 3, 4, 5; H, coxa 4; L, M, N, uropods 1, 2, 3; O, telson; P, female, 5.5 mm, dorsal configuration of pleon segments 3-6.

Uristes cansada n. sp.

(Fig. 21)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, female, 7 mm; ovigerous female, 5.5 mm. Total: 2 specimens.

Diagnosis:

Lateral lobes of head acute and projecting; anterior edge of lower lip slightly projecting in front of the flat epistomal margin; article 6 of gnathopod 2 expanding distally, 2.5 times as long as article 5, palm oblique but well defined by 2 large spines; hind lobe of article 5 very small; third pleonal epimeron with broad, short, protruding, acute tooth at lower corner, hind margin straight; pleon segment 4 with an erect, tall conical tooth.

Relationship:

J. L. Barnard (1961) has provided a condensation of the genus *Uristes* in which the species were listed in a new arrangement. Among these species are two with which the present species bears closest relationship, particularly by the similar first gnathopods: *U. gigas* Dana (= *Tryphosa antennipotens* Stebbing, 1888: pl. 6) which also has a dorsal tooth on pleon segment 4 but it is more prostrate and the third pleonal epimeron is broadly rounded behind; *U. umbonatus* (Sars 1895: pl. 29, fig. 2) which lacks an erect tooth on pleon segment 4 and has a quadrate lower corner on the third pleonal epimeron.

No clearly defined eyes were seen. The mouthparts correspond to *U. umbonatus*, referred to above.

Another specimen of the same species, with all parts identical to the figured holotype has a much smaller dorsal tooth on pleon segment 4, as figured.

One interesting feature of this species is the quadrate anterior lower corner of the first pleonal epimeron.

Uristes velia n. sp.

(Fig. 22)

Material:

St. 555, Great Australian Bight, 37°21′S 138° 44′E, 875 m, PGI 0.2, clay, a little sand, 6. XII. 1951. Male, holotype, 7 mm. Unique.

Diagnosis:

Eyes absent, lateral lobes of head narrow, subacute; antenna 1 stout, short, accessory flagellum 3-articulate; epistome and upper lip with straight anterior margins; coxa 1 scarcely tapering; coxa 4 narrow; palm of gnathopod 1 oblique but defined by a spine, article 7 bearing a tooth on the inner margin; lower edge of article 2 on pereopod 4 with large serrations; third pleonal epimeron with posterior edge nearly straight, lower corner quadrate; pleon segment 4 with upright tent-shaped process; rami of uropods 1 and 2 lack spines.

Mouthparts are like *U. gigas* (Stebbing, 1888: pl. 6) but the outer plate of the maxilliped bears one apical spine of medium to short size and the inner edge bears 6 blunt, stout spines.

Relationship:

This species differs from *U. gigas* Dana by the stout first antenna, the serrations of pereopod 4 and the non-tapering sixth article of gnathopod 1 (which may be an artifact in Stebbing's 1888 drawings).

The new species resembles *U. natalensis* K. H. Barnard, 1916, but differs by the well produced fourth pleon segment and the lack of spines on the rami of uropods 1 and 2.

Valettiopsis Holmes, 1908

Valettiopsis Holmes, 1908: 494-495.

This is one of three lysianassid genera known to have a dentate primary cutting plate on the mandible. The others are *Valettia* and *Alicella*. Neither Holmes (1908) nor Chevreux (1909) pointed out that the first coxa of *Valettiopsis* is small nor did they mention that it is largely hidden by coxa 2. It is presumed by the writer that this condition prevails in the known species of *Valettiopsis*.

Valettiopsis multidentatus n. sp.

(Fig. 23)

Material:

St. 665, Kermadec Trench, 36°38′S 178°21′E, 2470 m, grey clay, HOT, 25. II. 1952. Holotype, female, 18 mm. Unique.

Diagnosis:

Segments dorsally toothed, commencing with pereon segment 5 and continuing through pleon segment 4; the teeth large and acute on pereon segment 7, and pleon segments 1, 2 and 4, tooth blunter on pleon segment 3; gnathopod 2 with dis-

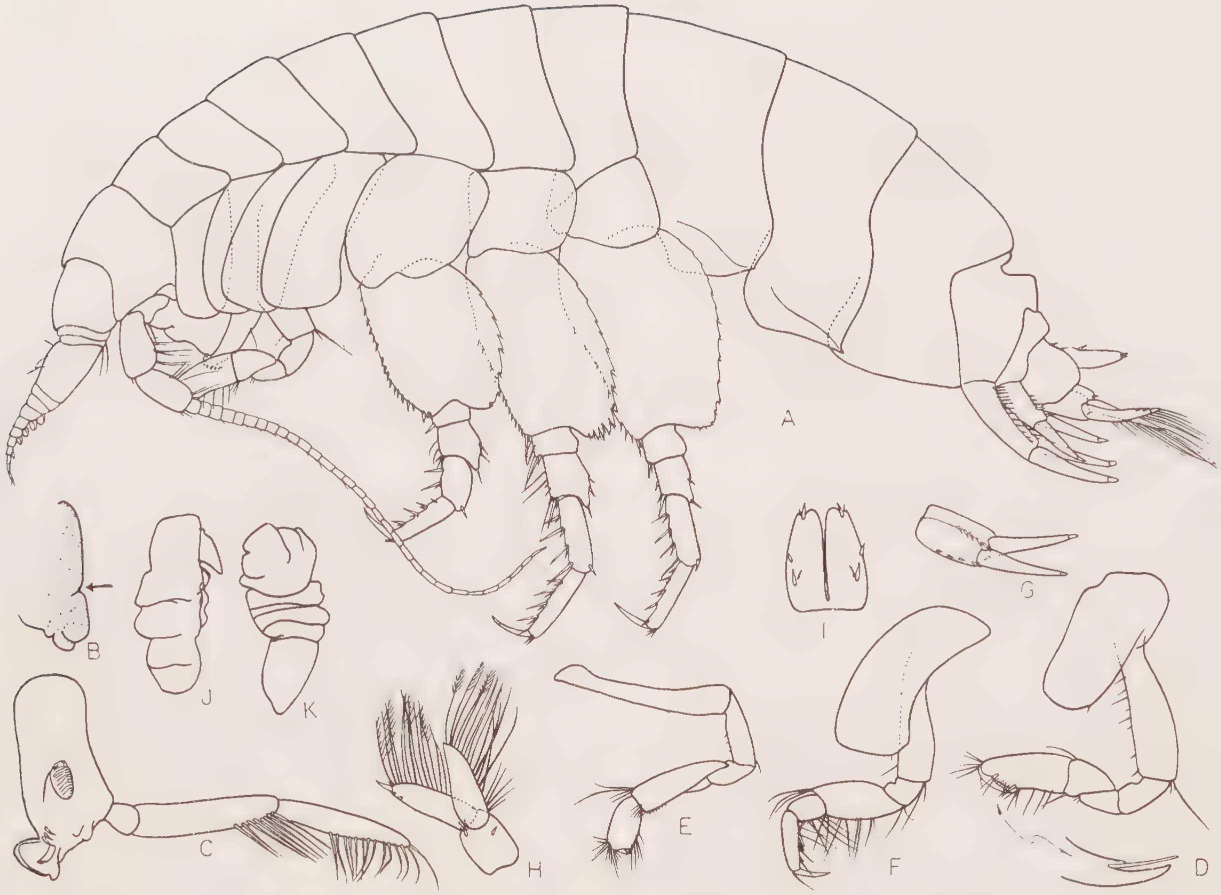


Fig. 22. *Uristes velia* n.sp. Male, holotype, 7 mm, St. 555. A, lateral view; B, epistome, arrow indicates front; C, mandible; D, E, gnathopods 1, 2; F, pereopod 1; G, H, uropods 2, 3; I, telson; J, K, gills.

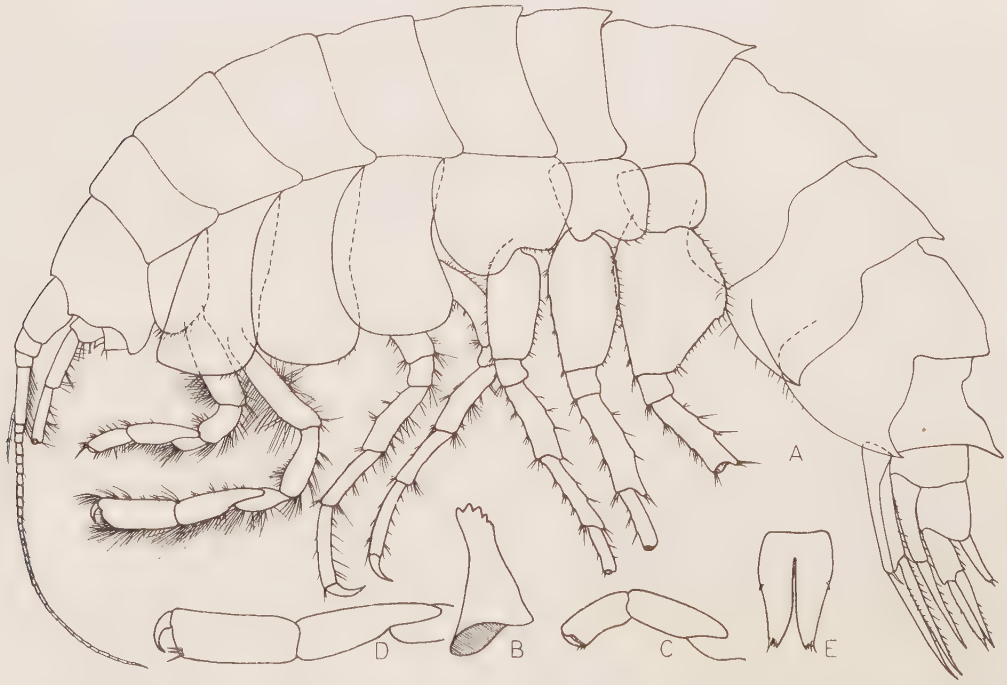


Fig. 23. *Valettiopsis multidentatus* n.sp. Female, holotype, 18 mm, St. 665. A, lateral view; B, body of mandible; C, D, gnathopods 1, 2; E, telson.

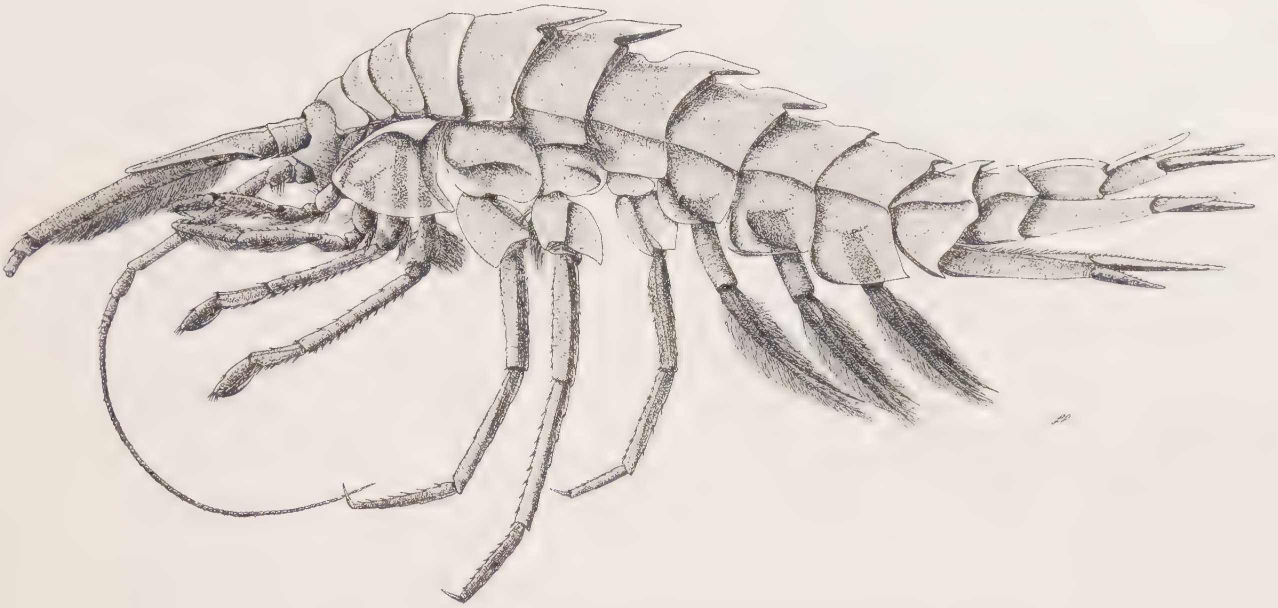


Fig. 24. *Parargissa galatheae* n.sp. Male, holotype, St. 194, 50 mm.

tinct, nearly transverse palm and long seventh article; pereopod 5 with article 2 broadly expanded and obliquely truncated below.

Relationship:

This species differs from the other known species *V.dentatus* Holmes, 1908 and *V.macrodactylus* Chevreux, 1909 by having more than the fourth pleonal segment dorsally toothed, six others being toothed. The large and well developed mouthparts and second gnathopod are like *V.macrodactylus* Chevreux, 1909.

FAMILY HYPERIOPSIDAE

Parargissa galatheae n. sp.

(Figs. 24, 25)

Material:

St. 194, off Durban, 34°09′S 30°45′E, 4360 m, Globigerina ooze, SOT, 7. II. 1951. Holotype, male, 50 mm.

Both third uropods and the telson are damaged, and the flagella of both first antennae are broken. In the drawing, uropod 3 is reconstructed from parts of both.

Diagnosis:

Body dorsally keeled, the keels large and produced into decumbent acute teeth projecting posteriorly on pereon segments 5-7 and pleon segment 1, the keels smaller but continuing to end acutely posteriorly on pleon segments 2-5; a lateral keel commencing on pereon segment 6 and terminating on pleon segment 5; pleon segment 6 lacking a middorsal keel but with its dorsolateral boundaries marked by a small sharp keel, so that the segment forms a rectangular block, with flat top and sides; head with acutely projecting lateral lobes; coxae 4-6 are rugged and stiff and bear surface ornamentation in the form of projecting, keel-like ridges (see drawings); article 1 of antenna 1 with lower distal corner produced to a short, acute tooth, article 2 produced laterally to a very long acute scale which is more than 3 times as long as article 1; article 2 short medially; article 3 much shorter than medial part of article 2 and bearing a slender accessory flagellum composed of 3 articles tipped with a small one; basal portion of primary flagellum very long, cylindrical, armed with ventral setae proximally; rest of antenna broken; article 5 of antenna 2 less than one fourth as long as article 4, flagellum about 2.5 times as long as article 4; epistome forming a very large bulbous anterior process fused to the head; upper lip with ventral edge broad and incised slightly but not deeply; third pleonal epimeron with straight posterior edge, lower corner prolonged acutely; telson damaged, slender, deeply cleft, apices bifid.

Relationship:

It is possible that this species is the adult of *Parargissa nasuta* Chevreux, 1908a which was described as a male, 5 mm. Often, males are determined only as animals lacking brood plates and *P.nasuta* may

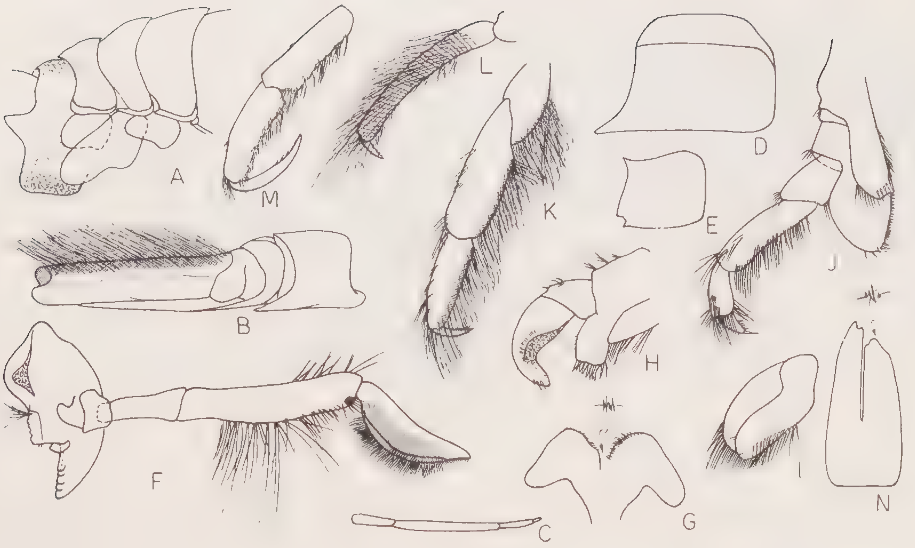


Fig. 25. *Parargissa galatheae* n. sp. Male, holotype, 50 mm, St. 194. A, head and first 3 pereon segments; B, antenna 1, oblique medial view; C, accessory flagellum; D, article 1 of antenna 1, lateral; E, article 3 of antenna 2, lateral; F, mandible; G, lower lip, damaged as marked; H, I, maxillae 1, 2; J, maxilliped; K, L, M, ends of gnathopods 1, 2 and pereopod 1; N, telson, damaged as marked.

simply be a juvenile animal. However, the transformation from *P. nasuta* to *P. galatheae* would require the following developments: acquisition of all ornamentation in the form of keels, teeth and ridges; a doubling of the relative length of the unsegmented basal portion of the first antennal flagellum so that it becomes twice as long as the scale of article 2; a further increase in the disproportion of articles 4 and 5 of antenna 2; the development of sharply acute lateral head lobes, instead of straight front edges; the asymmetrical and disproportionate enlargement of coxa 2; the shortening of article 2 on pereopod 5 so as to resemble the same articles on pereopods 3 and 4; and the shortening of the outer rami on uropods 1 and 2. The most serious objection to any thesis that *P. galatheae* is the adult of *P. nasuta* is the need for the remarkable change of article 2 on pereopod 5, which is sublinear in *P. nasuta* and oval in *P. galatheae*. It is unlikely that juveniles would not possess some evidence of the lateral head lobe or the large dorsal teeth and other adult features.

Parargissa galatheae is distinctly different from *P. arcuata* (Birstein and Vinogradov, 1955 and 1958), a species lacking ornamentation as in *P. nasuta,* but also lacking the scale of article 2 on antenna 1.

The first uropod is missing on the right side and the left one has the outer ramus considerably shorter than the inner which is probably the result of regrowth after damage, for the following new subspecies shows the outer ramus to be considerably longer. The same is true for the second uropod, which on the right side has a long outer ramus, nearly reaching the end of the inner but the left side shown in the drawing has this ramus shortened, as if damaged. The first antennal scale is also damaged apically.

Food:

The stomach contents were composed of numerous slender flakes of material which might be bits of epidermis or comminuted muscle strands, a few falcate flakes, some larger bulky brown particles resembling woody debris, and a very few small hooks, perhaps chitinous parts of polychaetes. All other members of the family Hyperiopsidae are pelagic so it is presumed the same is true for the present specimen.

Parargissa galatheae americana n. subsp.
(Fig. 26)

Material:

St. 716, Acapulco-Panama, 9°23′N 89°32′W, 3570 m, dark muddish clay, HOT, 6. V. 1952. Holotype, female, 42 mm. Unique.

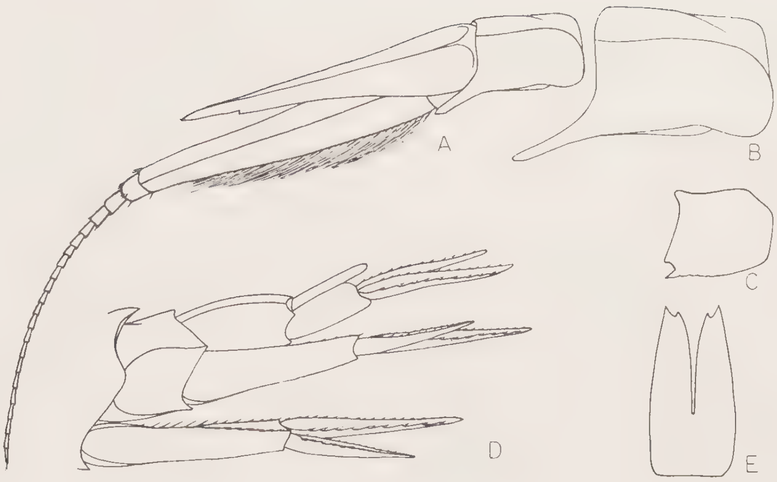
Diagnosis:

Like the type species except in the following characters: disto-lateral tooth of article 1 on antenna 1 much longer and more slender; dorsal tooth of pleon segment 2 slightly larger.

Remarks:

The specimen is less well preserved in many respects than the holotype of the type species, for the internal parts of the body are missing, resulting

Fig. 26. *Parargissa galatheae americana* n. subsp. Female, holotype, 42 mm, St. 716. A, antenna 1; B, article 1 of antenna 1; C, article 3 of antenna 2; D, uropods 1-3, lateral view; E, telson.



in a flabby mass of tissue. However, some of the parts which were damaged on the type species are in good condition, such as the first antennal flagellum, all the uropods and the telson. The outer rami of the uropods nearly reach the ends of the inner rami; the telson has bifid apices, but no spines or sockets are present in the notches. On the type species these appendages were damaged and abnormal as discussed above, so no subspecific differences are attributable to these conditions.

The principal difference is the more slender tooth of the first antenna. The dorsal tooth of pleon segment 2 may have been damaged on the type species specimen. The slight notch on the first antennal scale, drawn for the new subspecies was not apparent on the typical subspecies but in that case the scale was damaged apically.

FAMILY STEGOCEPHALIDAE

These animals are generally considered to be pelagic because of their ovoid and oily bodies, lack of eyes, and lack of mandibular palps and molars. In some cases the mouthparts are apparently modified for piercing and sucking but the laminar mandible might be considered useful for scraping benthic surfaces. Apparently there is no record of the animals having been caught in a benthic closing grab but the presence of mineral grains in the stomach contents of a few species indicates their demersal habits.

Euandania gigantea (Stebbing, 1888)

Andania gigantea Stebbing, 1888: 730, pl. 35.
Euandania gigantea, K. H. Barnard 1932: 80; Shoemaker 1945a: 194.

Material:

St. 66, off Gabon, 4°00′S 8°25′E, 4020 m, S 200C (5300 m wire), 5. XII. 1950. Specimen, 10 mm.
St. 194, off Durban, 34°09′S 30°45′E, 4360 m, Globigerina ooze, SOT, 7. II. 1951. Specimen, 47 mm.
St. 662, Kermadec Trench, 36°22′S 178°23′W, 4630 m, HOT, 23. II. 1952. Specimen, 34 mm.

Distribution:

Cosmopolitan between the polar circles, known depths, 3430-1281 m.

Parandania boecki (Stebbing, 1888)
(Fig. 27)

Andania boecki Stebbing, 1888: 735, pl. 36.
Parandania boecki, Stebbing 1906: 95-96; Walker 1909: 330; K.H. Barnard 1916: 131-132; Schellenberg 1926: 223, fig. 28c; Schellenberg 1926a: 300; Schellenberg 1931: 51; K.H. Barnard 1932: 77-79; fig. 35; Stephensen 1933: 22-23; K.H. Barnard 1937: 148; Shoemaker 1945: 194-195; Birstein and Vinogradov 1955: 239-240; Birstein and Vinogradov 1958: 238.
Parandania Boecki, Chevreux 1905: 7; Chevreux 1935: 66-67.
Parandania Boeckii, Pirlot 1930: 8-9.

Material:

St. 279, Seychelles-Ceylon, 1°00′N 76°17′E, 4320 m, ST 300, 8. IV. 1951. Female, 14 mm.
St. 660, Kermadec Trench, 35°35′S 178°51′W, 7800-7310 m, ST 600, 22. II. 1952. Male, 10 mm, figured.

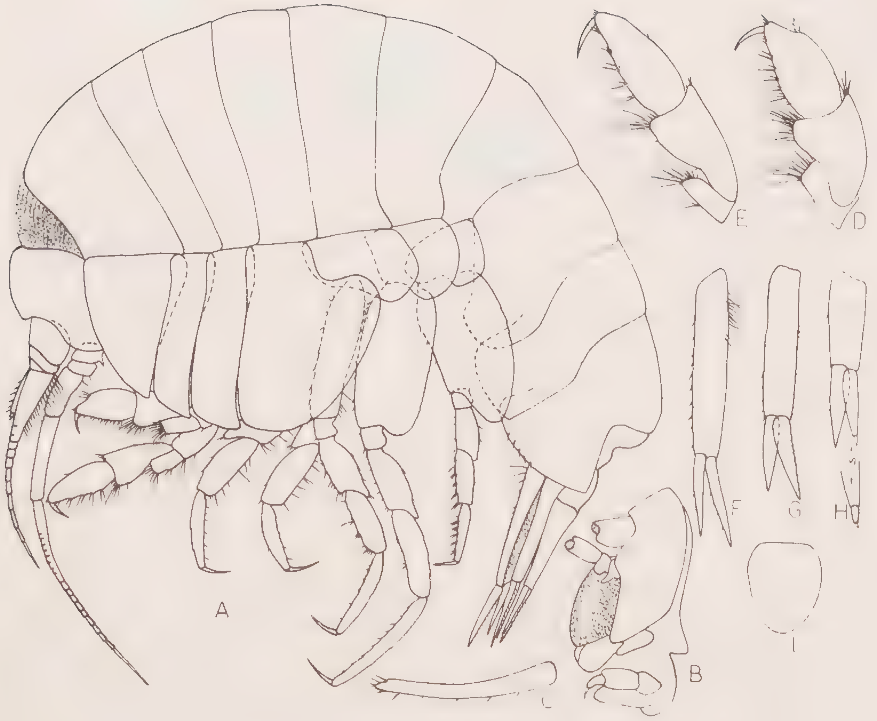


Fig. 27. *Parandania boecki* (Stebbing). Male, 10 mm, St. 660. A, lateral view, head pulled down; B, lateral view of head, epistome stippled; C, accessory flagellum; D, E, gnathopods 1, 2; F, G, H, uropods 1, 2, 3; I, telson.

Remarks:

The specimens exhibit several discrepancies from Stebbing's original drawings in the longer rami of the uropods and the less well developed accessory flagellum. Despite its common occurence only two groups of figures subsequent to the originals have been published and no one has worked out the morphological variations in the species. The present specimen is figured, for this reason.

Distribution:

Cosmopolitan, except for the arctic. Pelagic. Minimum recorded depth 300 m; minimum depth of closed haul 2200 m.

Food:

The stomach was filled with a spongy mass of material composed of finely particulate matter and three kinds of empty cell "tests", one kind spherical, another oval, the third a clavate sac. This species may feed on coelenterates or salps.

Phippsiella nipoma n. sp.

(Fig. 28)

Material:

St. 471, Sunda Trench, 10°26′S 114°15′E, 2990-2810 m, clay and vulcanic tuff, ST 300, 10. IX. 1951. Female, 8.5 mm, "sitting in a hole in the tuff-stone".

St. 607, Tasman Sea, 44°18′S 166°46′E, 3580 m, clay, HOT, 17. I. 1952. Female, 20 mm; female, 7 mm.

Vema St. 54, Cape Basin, south Atlantic Ocean, 4680 m. Holotype, ?sex, 2 mm.

Total: 4 specimens.

Diagnosis:

Rostrum poorly developed; third pleonal epimeron with a prolonged posterior edge, lower posterior corner angular, not produced, lacking evidence of a notch.

Relationship:

This species differs from other known species by the shape of the third pleonal epimeron which is neither serrated as in *P. similis* (in Sars 1895: pl. 70, fig. 1) nor notched as in *P. minima* Stephensen, 1925 (p. 131) and *P. kergueleni* Schellenberg, 1926 (p. 220). The rostrum is small, unlike *P. rostrata* K. H. Barnard, 1932 (p. 76). The holotype will be figured in Barnard (1961 b).

Distribution:

Apparently a widely distributed species of bathypelagic and demersal habits: South Atlantic, Tasman Sea, Java Deep, caught in hauls of maximum depth ranging from 1861 m to 4680 m, probably in midwater.

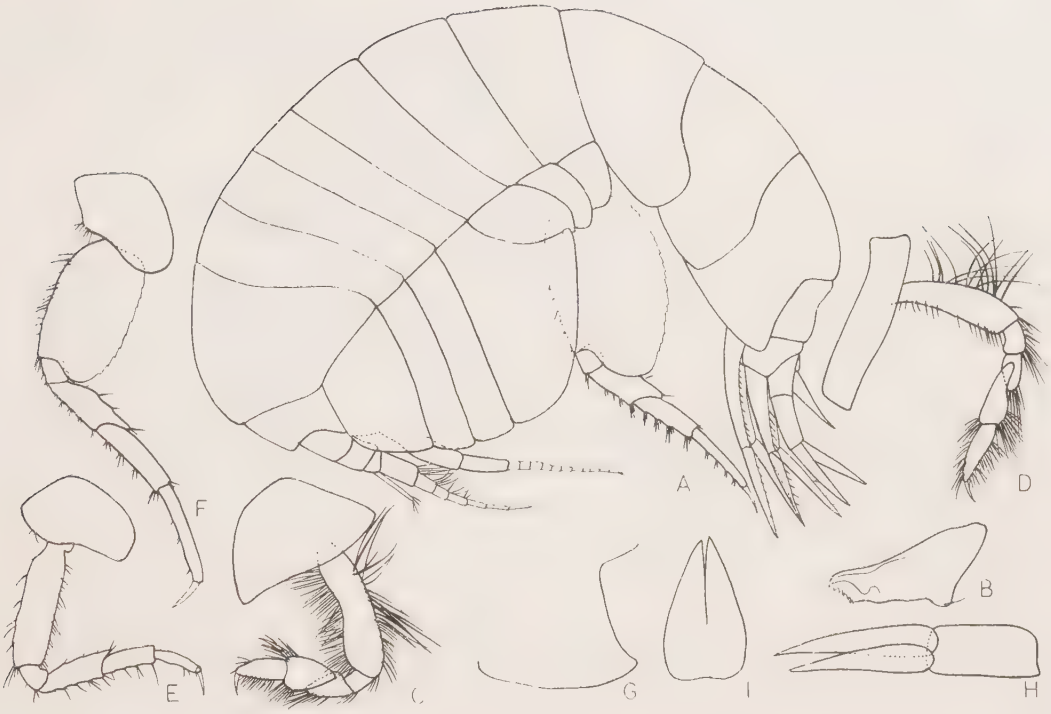


Fig. 28. *Phippsiella nipoma* n. sp. Female, 8.5 mm, St. 471. A, lateral view; B, mandible; C, D, gnathopods 1, 2; E, F, pereopods 3, 4; G, third pleonal epimeron; H, uropod 3; I, telson.

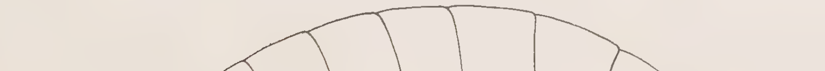


Fig. 29. *Stegocephaloides attingens* K. H. Barnard. Female, 4 mm, St. 101. A, lateral view; B, C, gnathopods 1, 2; D, uropod 3; E, telson; F, third pleonal epimeron.

Stegocephaloides attingens K. H. Barnard, 1916
(Fig. 29)

Stegocephaloides attingens K. H. Barnard, 1916: 131, pl. 26, fig. 5.

Material:
St. 101, off Angola, 8°50′S 12°32′E, 990 m, greenish mud, ST 300, 12. XII. 1950. Female, 4 mm.

Remarks:
This species is closely related to *S. auratus* (Sars, 1895: pl. 70, fig. 3) but has only one serration on the third pleonal epimeron. The accessory flagellum is slightly shorter, less serrations occur on article 2 of pereopod 5 and coxa 4 is less truncate below.

Stegocephaloides attingens is like *S. christianensis* (in Sars 1895: pl. 70, fig. 2) but the second article of pereopod 3 is longer and narrower.

Food:
About 50 % of the stomach contents consisted of mineral particles, the remainder of finely particulate organic matter.

Distribution:
Angola to Cape of Good Hope, 990-1280 m.

FAMILY AMPELISCIDAE

Ampelisca albedo n. sp.
(Fig. 30)

Material:
St. 638, Wellington-Auckland, 37°33′S 175°57′E, 660 m, clay with a little sand, PGI 0.2, 26. I. 1952. Holotype, female, 7 mm. Unique.

Diagnosis:
Head broad, lower front edge protruding and expanded; only upper pair of corneal lenses present and they are quite large; lower pair absent; article

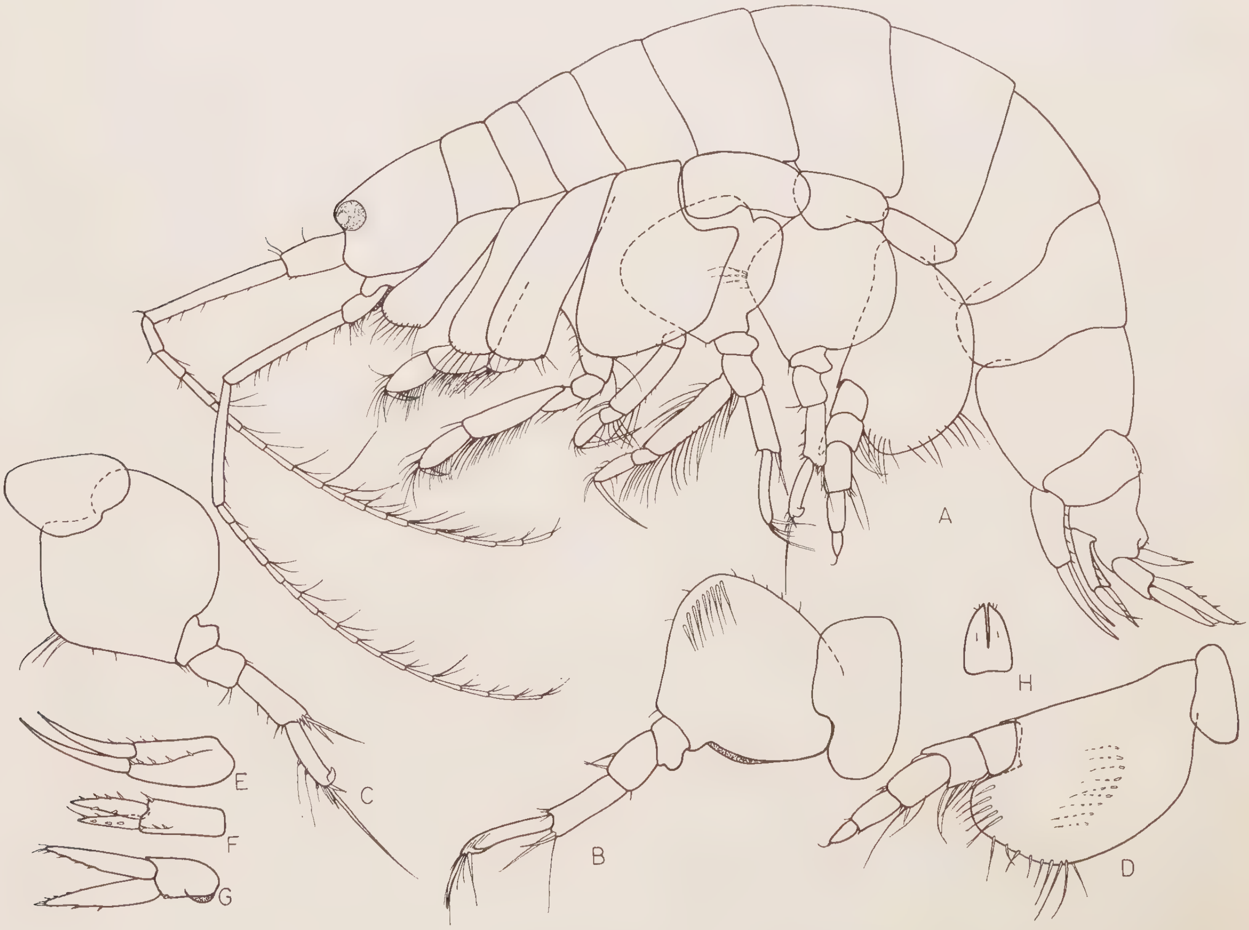


Fig. 30. *Ampelisca albedo* n. sp. Female, holotype, 7 mm, St. 638. A, lateral view; B, C, D, pereopods 3, 4, 5; E, F, G, uropods 1, 2, 3; H, telson.

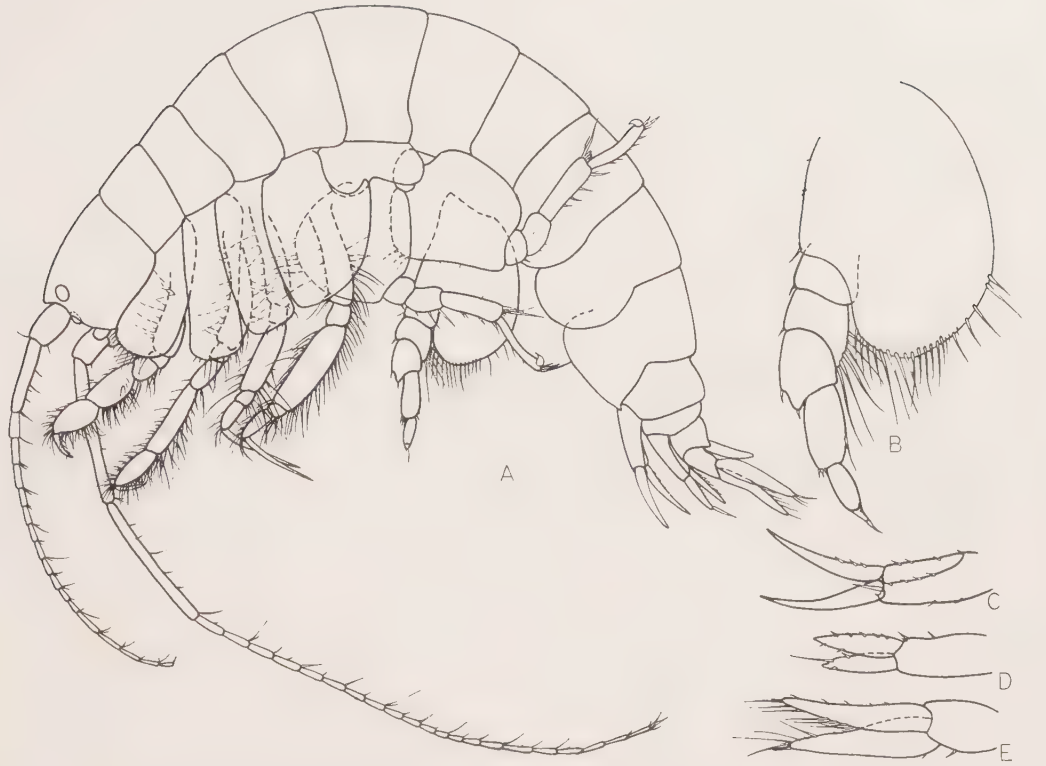


Fig. 31. *Ampelisca chiltoni* Stebbing. ?Male, 9 mm, St. 626. A, lateral; B, pereopod 5; C, D, E, uropods 1, 2, 3.

2 of antenna 1 twice as long as article 1; antennae 1 and 2 equal in length, about three fourths as long as body; coxae 1-3 each with a small tooth at lower posterior corner; articles 3 and 4 of pereopod 5 equal in length, articles 5-7 slender, decreasing in length and breadth; third pleonal epimeron with a slightly convex posterior edge and a medium-sized tooth at the lower corner; pleon segment 4 with a small massive dorsal hump, not keel-shaped; uropod 1 reaching end of uropod 2, rami long, naked; outer ramus of uropod 2 bearing a long apical spine; rami of uropod 3 lanceolate; apices of telson acute and attenuated.

Relationship:

This species is related to *Ampelisca hemicryptops* K. H. Barnard, 1930 and *A. barnardi* Nicholls, 1938, but lacks the lower pair of concealed lenses on the head. It has been examined with great care in this regard.

Two other species of *Ampelisca, A. brachyceras* Walker, 1904 and *A. misakiensis* Dahl, 1944 possess only a single dorsal pair of lenses but each species has quite a different fifth pereopod in comparison with *A. albedo*. See J. L. Barnard (1960) for a key to *Ampelisca* and the shapes of fifth pereopods for all species of *Ampelisca*.

Ampelisca chiltoni Stebbing, 1888
(Fig. 31)

Ampelisca chiltoni Stebbing, 1888: 1042, pl. 103.

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Young male, 9 mm, figured; and a 4 mm juvenile. Total: 2 specimens.

Diagnosis:

Head with lower front edge oblique, nearly transverse; eyes larger than shown by Stebbing, the lower pair oriented to point forward; first antenna only slightly longer than peduncle of second, article 2 about half again as long as article 1; article 4 of pereopod 5 slightly longer than 3, posterior edge with a small flat lobe; article 5 with an anterior notch; article 6 only slightly longer than 5; uropod 1 nearly reaching end of uropod 2, its outer ramus not spinulate; uropod 2 having a long apical spine on outer ramus; uropod 3 rather long; telson long, narrow, apices slightly incised, each with a stout spine; third pleonal epimeron with posterior edge smoothly convex, lower corner with a small tooth; pleon segment 4 with dorsal edge slightly elevated, flat, but not carinate, posterior corner angular.

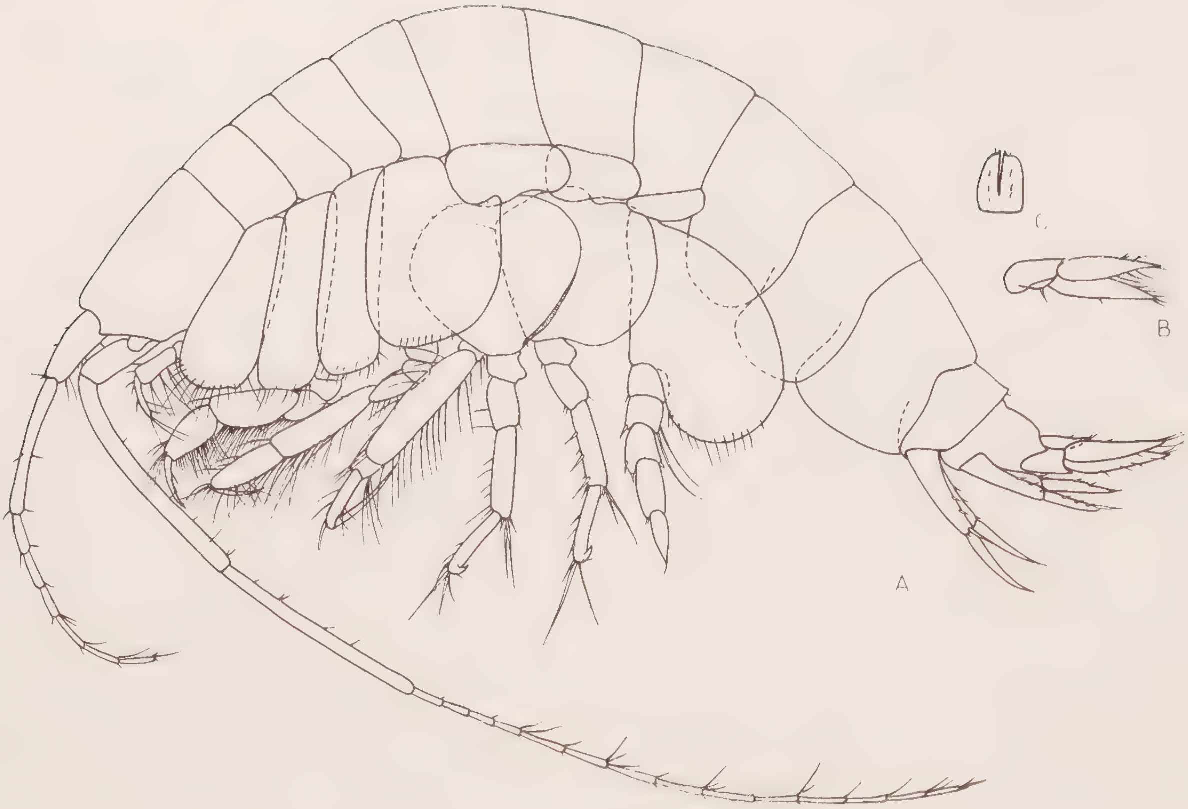


Fig. 32. *Ampelisca gusta* n. sp. Female, holotype, 4.5 mm, St. 241. A, lateral view; B, uropod 3; C, telson.

Remarks:

STEBBING's drawing of the third epimeron on the wholemount failed to show the small tooth but his other enlarged drawing showed it as in the present specimens. This is the second record of the species.

Distribution:

New Zealand, 282 m; Tasman Sea, 610 m.

Ampelisca gusta n. sp.

(Fig. 32)

Material:

St. 241, off Kenya, 4°00′S 41°27′E, 1510 m, pure Globigerina, HOT, 15. III. 1951. Holotype, female?, 4.5 mm. Unique.

Diagnosis:

Corner of head near first antenna produced, margin below that oblique; corneal lenses absent; antenna 1 shorter than peduncle of antenna 2, article 2 twice as long as article 1; antenna 2 as long as body; articles 3 and 4 of pereopod 5 subequal in length, articles 5 and 6 subequal, article 5 with an anterior spine, article 2 produced downward to the end of article 4, its lower edge rounded; third pleonal epimeron with slightly convex posterior edge and small lower tooth; pleon segment 4 with a low dorsal, massive but angular process; uropod 1 failing to reach the end of uropod 2, rami naked; outer ramus of uropod 2 with apical spine; rami of uropod 3 lanceolate, moderate in stoutness; telson broad, apices blunt except for medial cusps.

Relationship:

This species bears a remarkable resemblance to *Ampelisca catalinensis* J.L. Barnard, 1954 (= *A. eoa?,* see J.L. BARNARD 1960) and has been compared directly with the holotype specimen of *A. catalinensis*. *Ampelisca gusta* differs from *A. catalinensis* only by the shorter first antenna, the more produced lateral corner of the head and the slightly stouter rami of the third uropods. Young *A. catalinensis* specimens have the fifth article of pereopod 5 shorter than in J.L. BARNARD's (1954) figures of a large adult and are more like *A. gusta* in this respect; however, the rami of the third uropods are just as slender in young as in adult *A. catalinensis*.

The new species is related to *Ampelisca bransfieldi* K.H. Barnard, 1932, but the tooth on the third pleonal epimeron is smaller and the lateral corner of the head is more produced. From *A.*

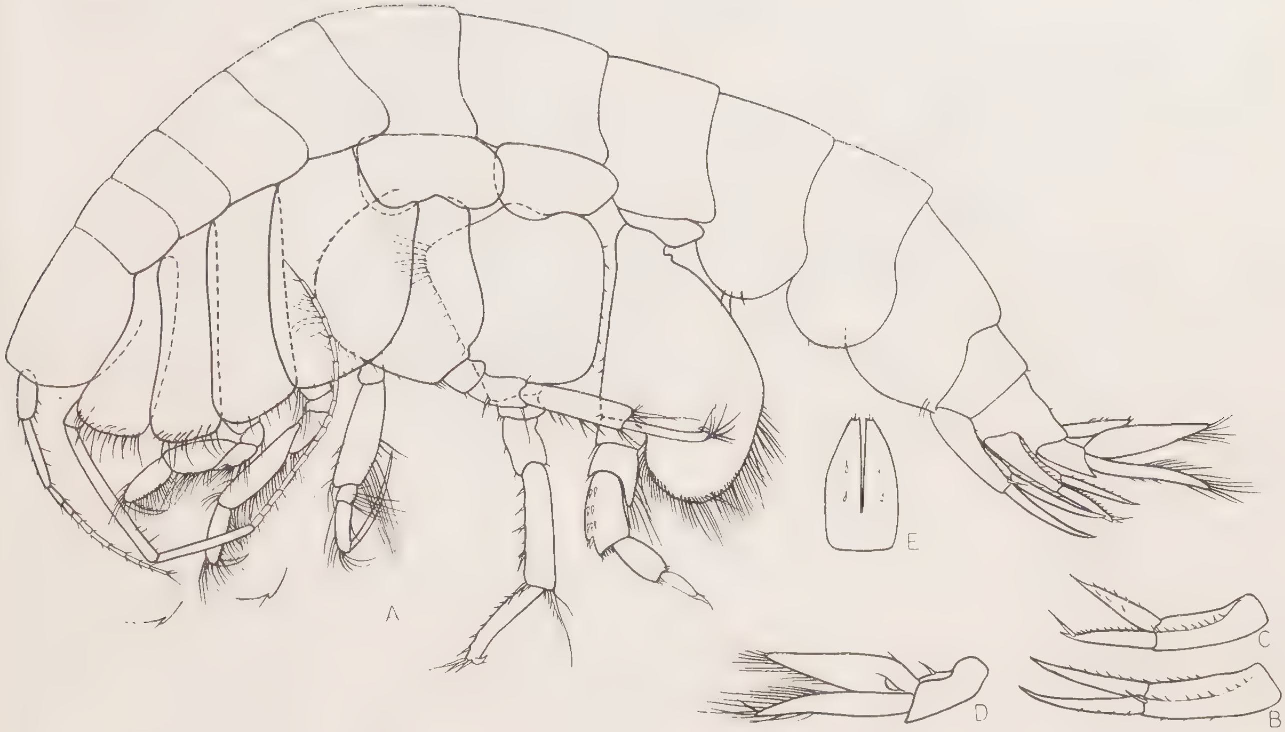


Fig. 33. *Ampelisca hermosa* n. sp. Female, holotype, 14 mm, St. 742. A, lateral view; B, C, D, uropods 1, 2, 3; E, telson.

coeca Holmes, 1908 (see J. L. Barnard 1960) the new species differs by the longer second article of the first antenna. *A. gusta* is related also to *A. amblyopsoides* J. L. Barnard, 1960, but in *A. amblyopsoides* the first uropod fully reaches the end of uropod 2, the rami are spinose, the tooth on the third pleonal epimeron is larger, the lateral corner of the head is less produced and the second article of antenna 1 is shorter.

It must be remarked that from these materials and those of Barnard (1960, eastern Pacific) and Barnard (1961, south Atlantic) more evidence is accumulating on the remarkable similarity of the various bathyal species of *Ampelisca,* and many of them may prove to belong to a complex of subspecies.

Ampelisca hermosa n. sp.

(Fig. 33)

Material:

St. 742, Gulf of Panama, 7°28′N 79°37′W, 500 m, green clay, PGI 0.2, 16. V. 1952. Holotype, female, 14 mm; two other specimens, 12 and 9 mm. Total: 3 specimens.

Diagnosis:

Head broad, with lower front edge oblique, corneal lenses absent; antenna 1 reaching slightly beyond end of peduncular article 4 of antenna 2; article 2 of antenna 1 about 1.3 times as long as article 1; antenna 2 about half as long as animal; lower posterior corners of coxae 1 and 2 with a small slit; article 2 of pereopod 5 convex, extending down to end of article 4, article 4 longer than article 3, posterior lobe small, article 5 longer than articles 3-4 combined, bearing an anterior notch and 3 sets of lateral spines, articles 6 and 7 shorter and more slender than article 5; third pleonal epimeron with slightly convex posterior edge and a small sharp tooth at the lower posterior corner; uropod 1 reaching to the end of uropod 2; uropod 2 with a long apical spine on the outer ramus; rami of uropod 3 slender, lanceolate; telson evenly tapering, apices of lobes incised; pleon segment 4 with a low, simple dorsal process.

Relationship:

This eastern Pacific animal appears to be a geminate species of the bathyal Caribbean *Ampelisca abyssicola* Stebbing, 1888 (pl. 104) from 714 m. It is particularly related by the long fifth article of pereopod 5 and has only slight, perhaps unimportant differences from *A. abyssicola,* as follows: article 5 of antenna 2 is shorter; pleon segment 3 has

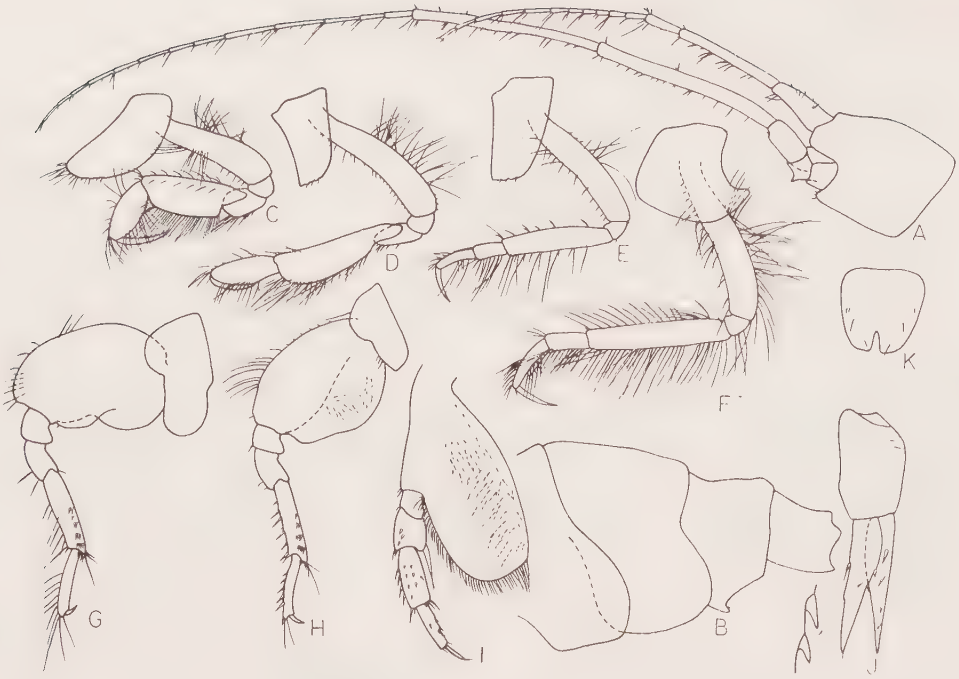


Fig. 34. *Byblis ceylonica* n.sp. Female, holotype, 15 mm, St. 281. A, head; B, pleon segments 2-6 (5-6 fused); C, D, gnathopods 1, 2; E, F, G, H, I, pereopods 1, 2, 3, 4, 5; J, uropod 3; K, telson.

a distinct tooth instead of being quadrate; and pleon segment 4 has a dorsally straight-margined process, not slightly saddle-shaped.

Byblis ceylonica n. sp.

(Fig. 34)

Material:

St. 281, Seychelles-Ceylon, 3°38′N 78°15′E, 3310 m, Globigerina ooze, ST 300, 10. IV. 1951. Holotype, female, 15 mm. Unique.

Diagnosis:

Eyes absent; antenna 2 three fourths as long as body, antenna 1 broken, probably exceeding peduncle of antenna 2; cleft of telson one fourth its length; rami of uropod 3 not serrate but armed with a few stout spines; anterolateral head angle not cuspate; third pleonal epimeron with posterior edge bulging slightly, rounded at lower corner; hind lobe of article 2 on pereopod 5 densely setose; coxae 1-3 with distal anterior corners angular and slightly prolonged, lower edges serrate, coxa 1 moderately setose, coxae 2-3 poorly setose.

Relationship:

In other respects the species has the aspect of *Byblis barbarensis* J.L. Barnard, 1960, with the first 2 uropods similar, the first with a distolateral spine on the peduncle, but the gnathopods are much smaller in relation to the body than in *B. barbarensis*. The new species differs from *B. barbarensis* specifically by the poorly cleft telson, the shape of the first 3 coxae, which in *B. barbarensis* are rounded in front, and the unserrated rami of uropod 3.

The blindness of the species and the shortness of the telsonic cleft relates *B. ceylonica* to *B. abyssi* (see key in J.L. Barnard 1960), but it differs from *B. abyssi* by the non serrate rami of the third uropods, the rounded-bulging, not subquadrate, third pleonal epimeron, and the angular first 3 coxae.

The new species is also closely related to *B. serrata* (see *B. minuticornis* in Sars 1895: pl. 66, fig. 3) but differs by the first antenna reaching to the end of the peduncle of the second antenna, whereas in *B. serrata* it scarcely exceeds the fourth peduncular article of the second antenna. It differs also by the less deeply cleft telson and the angular first 3 coxae.

Byblisoides arcillis n. sp.

(Fig. 35)

Material:

St. 453, Makassar Strait, 3°56′S 118°26′E, 2000 m, greenish clay, ST 300, 24. VIII. 1951. Holotype, male, 10 mm.

St. 491, Makassar Strait, 4°56′S 117°39′E, 1560 m, muddy clay, ST 300, 14. IX. 1951. Female, 9 mm.

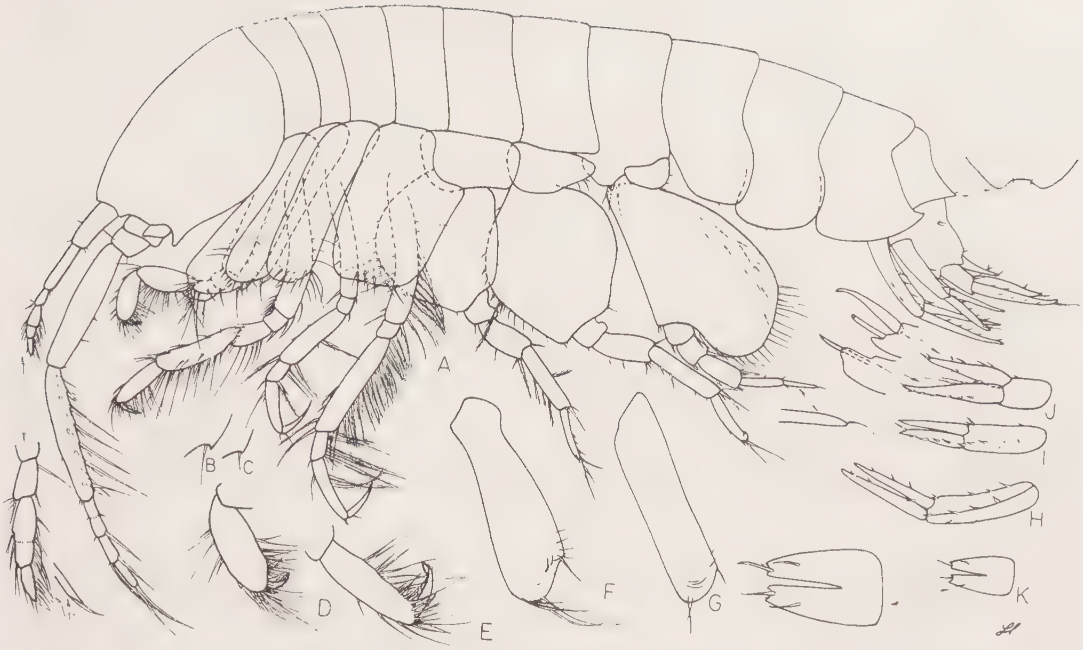


Fig. 35. *Byblisoides arcillis* n. sp. Male, holotype, 10 mm, St. 453. A, lateral view; B, C, lower hind corners of coxae 1, 2; D, E, gnathopods 1, 2; F, G, coxae 1, 2; H, I, J, uropods 1, 2, 3; K, telson.

Diagnosis:

Lower edge of the lobe on the second article of pereopod 5 evenly rounded; anterior edge of fifth article on pereopod 5 lacking long plumose setae; lower anterior corners of articles 4 and 5 on pereopod 5 each bearing a short, blunt spine; article 7 of pereopod 5 equal to article 6 in length; antenna 2 about twice as long as head; anterior part of lower edge on coxa 1 convexly produced and setose, behind which the margin sweeps upward to the posterior corner and is bare of major setae; dorsal process of pleon segment 4 acute from lateral view, composed of two rounded bilateral lobes from dorsal view.

Relationship:

The shape of the first coxa is the most striking difference of this species when compared with the type species, *Byblisoides juxtacornis,* and *B. esferis* n. sp., to follow. The dorsal view of the fourth pleonal segment was not described for *B. juxtacornis* by K. H. Barnard (1932), but its bilobate character is a distinctive contrast to *B. esferis.* Gill lamellae are beautifully preserved in this specimen; they are white, shiny, flattened oval sacs, with no surface ornamentation.

Byblisoides esferis n. sp.
(Fig. 36)

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, ST 300, 20. I. 1952. Holotype, male?, 7 mm and 2 other specimens, est. 12 mm (broken), and 7 mm. Total: 3 specimens.

Diagnosis:

Lower edge of the lobe on the second article of pereopod 5 evenly rounded; anterior edge of fifth article on pereopod 5 lacking long plumose setae; lower anterior corners of articles 4 and 5 on pereopod 5 each bearing a short, blunt spine; article 7 of pereopod 5 shorter than article 6; antenna 2 short, only 1.5 times as long as head, contrasted with twice as long as in the type species, *Byblisoides juxtacornis* K. H. Barnard (Barnard 1932: 87); coxa 1 evenly rounded below; dorsal edge of pleon segment 4 straight, not ornamented.

Relationship:

Except for the fact that the description of still another new species in this genus precedes, it would have been practical to include the present material from the Tasman Sea in the type species *B. juxtacornis* from the Palmer Archipelago, considering the minute differences. At first sight, the differences are easily overlooked and the geographic separation be-

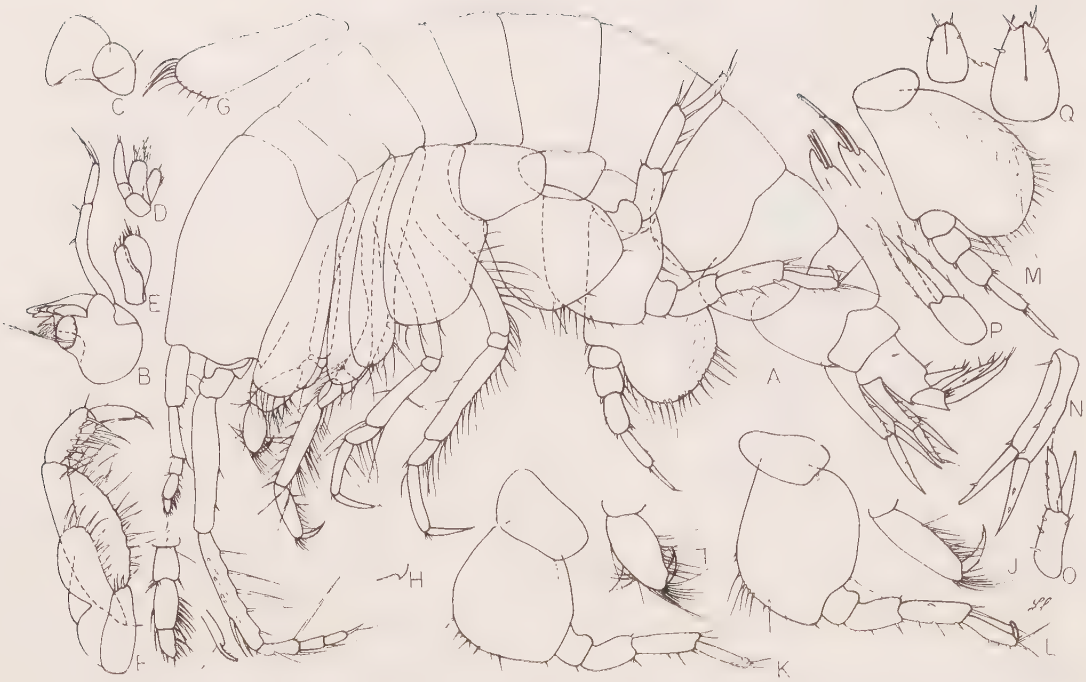


Fig. 36. *Byblisoides esferis* n. sp. ?Male, holotype, 7 mm, St. 626. A, lateral view; B, mandible; C, half of lower lip; D, E, maxillae 1, 2; F, maxilliped; G, coxa 1; H, lower tooth of coxa 1; I, J, gnathopods 1, 2; K, L, M, pereopods 3, 4, 5; N, O, P, uropods 1, 2, 3; Q, telson.

tween the Palmer Archipelago and deep waters of the Tasman Sea is no greater a barrier than between California and the Galapagos, which have some identical faunal elements. However, *B. arcillis* n. sp., preceding, was collected in the Makassar Strait, near the Equator and in a complex faunal region where direct gene flow with the Antarctic is unlikely, especially in bathybenthic organisms. The differences of the Makassar species from the Antarctic one are no greater than between the Tasman and Antarctic ones, indicating the need for specific segregation of all three species. No doubt, these minute differences might suggest subspeciation, and the writer has no quarrel with this view. However, it is occasionally the case that the more peculiar or unusual a genus is in comparison with its familial relatives, the more minor will be its interspecific differences. As a genus, composed of only the type species, *Byblisoides* is indeed unusual in the Ampeliscidae, where most of the other genera are immensely polyspecific. It is also peculiar in its generic morphological criteria, the club-like first antenna, the short antennal flagella and the lower head process.

All of the diagnostic features quoted above specifically distinguish the new species from *B. juxtacornis*.

The upper lip is broadly and slightly incised asymmetrically. Otherwise, the mouthparts have been figured.

Haploops Liljeborg, 1855

A key to this interesting genus is given below. The genus *Haploops* is characterized by the nearly linear second article of pereopod 5 and on this basis I believe that *H. securiger* K. H. Barnard (Barnard 1932) should be transferred to the genus *Byblis*.

Shoemaker (1931) suggested and Dunbar (1954) consummated the removal of *H. robusta* Sars to *H. setosa* Boeck. Neither author mentioned the presence or absence of a row of spines on the lower edge of article 3 of pereopod 5, a character useful in separating *H. spinosa* Shoemaker, 1931 from *H. tubicola* Liljeborg (see Sars 1895). Until this point can be elucidated I am provisionally reviving *H. robusta* in the following key.

Key to Haploops

1. Corneal lenses present 2
1. Corneal lenses absent 7
2. Corneal lenses two in number 3
2. Corneal lenses four in number 5
3. Female antenna 1 as long as 2 4
3. Female antenna 1 reaching only to end of peduncle of antenna 2 .... *descansa* n. sp.
4. Lower edge of article 3 of pereopod 5 spinose .... *spinosa*
4. Lower edge of article 3 of pereopod 5 not spinose .... *tubicola*
5. Pereopod 5, articles 6-7 together much shorter than article 3 .... *dellavallei*
5. Pereopod 5, articles 6-7 together longer than article 3 6
6. Pereopod 5, article 5 with long anterior lobe .... *sibirica*
6. Pereopod 5, article 5 lacking distinct anterior lobe .... *laevis*
7. Pereopod 5, articles 4-7 decreasing in length and width in a normal sequence, articles 6 and 7 half as wide as 5 .... *abyssorum*
7. Pereopod 5, article 6 much more slender than 5, articles 6 and 7, $^{1}/_{3}$ or less as wide as 5 8
8. Pereopod 5, posterior lobe of article 2 projecting slightly below end of article 3 9
8. Pereopod 5, posterior lobe of article 2 very small, scarcely evident 11
9. Lower edge of article 3 on pereopod 5 spinose 10
9. Lower edge of article 3 on pereopod 5 not spinose .... *setosa* and *proxima*
10. Uropod 1 nearly reaching end of uropod 2, article 2 of pereopod 5 about 2.5 times as wide as article 4 .... "*robusta*"
10. Uropod 1 shortened, article 2 of pereopod 5 less than 1.5 times as wide as article 4... *lodo* n. sp.
11. Pereopods 3-4, article 5 produced distally, inner ramus of uropod 1 shorter than outer... *similis*
11. Pereopods 3-4, article 5 not produced distally, inner ramus of uropod 1 equal to outer in length .... *vallifera*

Haploops descansa n. sp.
(Fig. 37)

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, ovigerous female, 7 mm. Unique.

Diagnosis:

Head with transverse front edge, a pair of upper corneal lenses present; antenna 1 shorter than peduncle of antenna 2, the latter shorter than the body; article 2 of pereopod 5 with concave hind margin, produced below into a lobe nearly reaching the end of article 3; lower edge of article 3 not spinose; articles 6-7 together shorter and less than one fifth as wide as article 5, article 5 lacking distinct distal lobes; fifth articles of pereopods 3 and 4 not distally produced; third pleonal epimeron with straight hind edge and rounded lower corner; inner ramus of uropod 1 shorter than outer; rami of uropod 2 subequal; telson short, cleft nearly to base.

Relationship:

See the preceding key to the genus *Haploops*. The species bears closest resemblance to *H. tubicola* Liljeborg (see Sars 1895: pl. 67) but differs by the short first antenna and the equal sized rami of uropod 2. It is also closely related to *H. spinosa* Shoemaker, 1931, differing mainly by the lack of spines along the lower edge of article 3 on pereopod 5 and the straight hind margin of the third pleonal epimeron.

Haploops lodo n. sp.
(Fig. 38)

Material:

St. 716, Acapulco-Panama, 9°23'N 89°32'W, 3570 m, dark muddish clay, HOT, 6. V. 1952. Holotype, female, 7.5 mm, figured; and 6 other specimens. Total: 7 specimens.

Diagnosis:

Front edge of head nearly transverse; eyes and corneal lenses absent; antenna 1 reaching end of peduncle of antenna 2, the latter broken on all specimens but probably shorter than body; article 2 of pereopod 5 slender, with concave hind margin, produced below into a lobe reaching the end of ar-

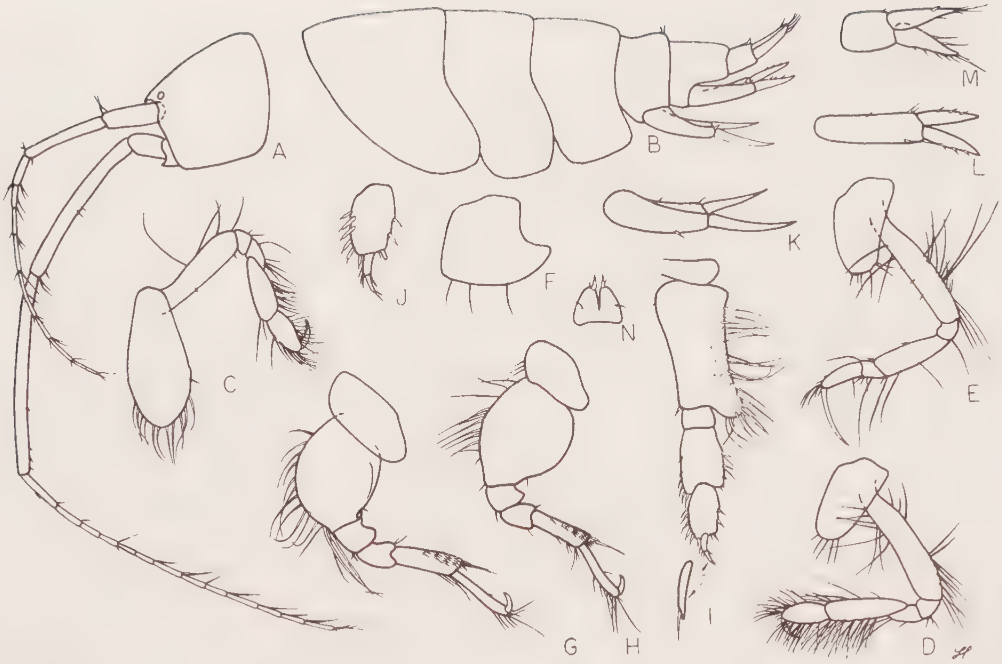


Fig. 37. *Haploops descansa* n. sp. Female, holotype, 7 mm, St. 626. A, head; B, pleon; C, D, gnathopods 1, 2; E, G, H, I, pereopods 1, 3, 4, 5; F, coxa 4; J, end of pereopod 5; K, L, M, uropods 1, 2, 3; N, telson.

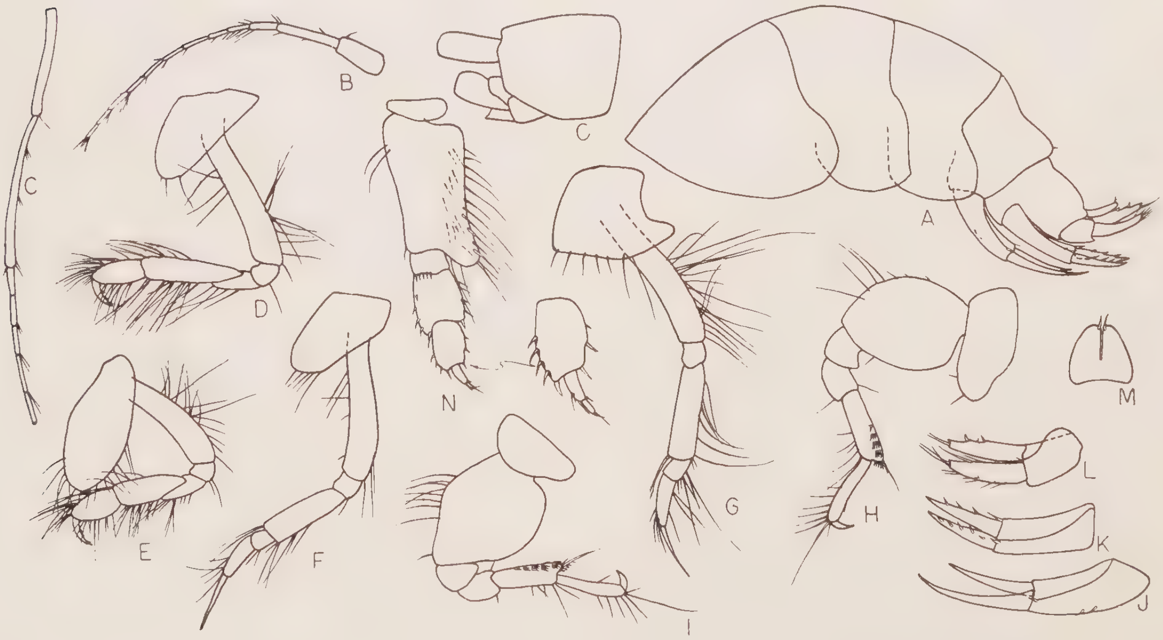


Fig. 38. *Haploops lodo* n. sp. Female, holotype, 7.5 mm, St. 716. A, pleon; B, C, antennae 1, 2; D, E, gnathopods 2, 1; F, G, H, I, N, pereopods 1, 2, 3, 4, 5; J, K, L, uropods 1, 2, 3; M, telson; O, head of another specimen.

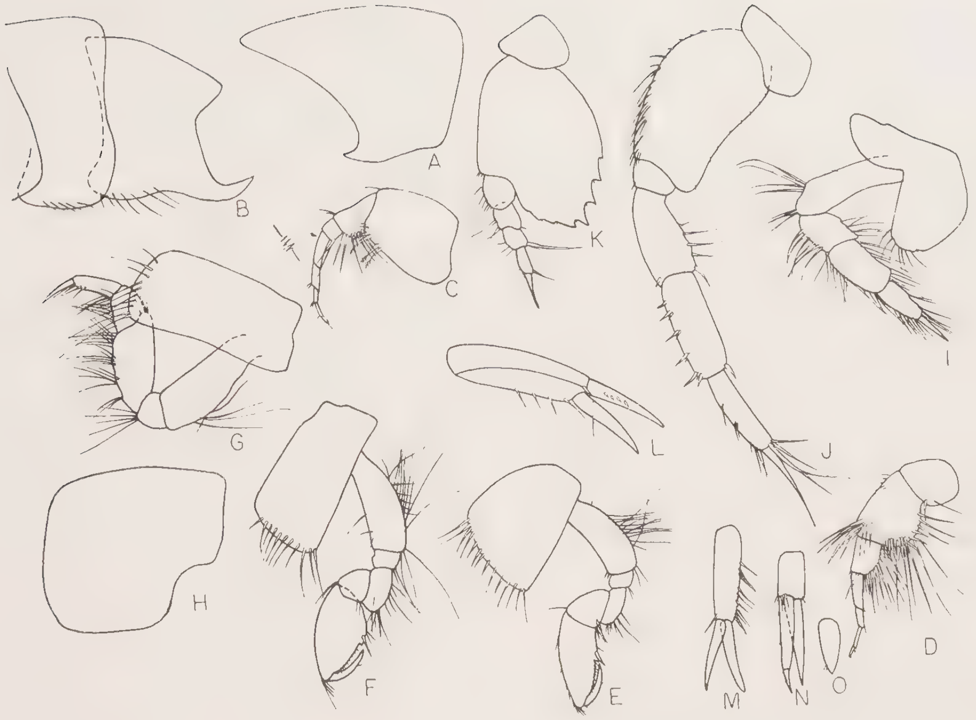


Fig. 39. *Harpinia australis* n. sp. Female, holotype, 5 mm, St. 554. A, head; B, pleon segments 2, 3; C, D, antennae 1, 2, accessory flagellum broken; E, F, gnathopods 1, 2; G, I, J, K, pereopods 1, 3, 4, 5; H, coxa 4; L, M, N, uropods 1, 2, 3; O, half of telson.

ticle 3; lower edge of article 3 spinose; articles 6 and 7 together shorter and less than one fourth as wide as article 5; article 5 bearing a small distal anterior lobe; fifth articles of pereopods 3 and 4 not distally produced; third pleonal epimeron with bulging posterior edge and rounded lower corner; inner ramus of uropod 1 shorter than outer, the outer ramus barely exceeding the peduncle of uropod 2; rami of uropod 2 subequal; telson short, cleft about two thirds its length.

Relationship:

This species is very closely related to *Haploops robusta* (in Sars 1895: pl. 68, fig. 2) but differs by the shortened first uropod, the lesser cleft telson, the narrower second article of pereopod 5, the shorter first antenna and the shape of the rami on uropod 3, for which figures should be compared.

FAMILY PHOXOCEPHALIDAE

Harpinia abyssalis Pirlot, 1932

Harpinia abyssalis Pirlot, 1932: 69-74, figs. 16-18; J. L. Barnard 1960a: 347 (and key).

Material:

St. 477, S. of Bali, 9°01′S 114°48′E, 780 m, sandy clay, PGI 0.2, 11. IX. 1951. Female, 5.5 mm.

Distribution:

Flores Sea, Makassar Strait and northern Indian Ocean south of Bali (scarcely removed from Flores Sea), 780-1310 m.

Harpinia australis n. sp.
(Fig. 39)

Material:

St. 554, Great Australian Bight, 37°28′S 138°55′E, 1340-1320 m, Globigerina ooze, ST 300, 5. XII. 1951. Holotype, female, 5 mm. Unique.

Diagnosis:

Head with large acute lower tooth; article 2 of pereopod 5 reaching down to end of article 4, lower posterior edge with 3 large and blunt teeth bounded on each side by a small one, anterior edge lacking expanded setal row; third pleonal epimeron with sinuate lower edge and a very long upturned posterior tooth; outer ramus of uropod 1 bearing 4 short spines, inner ramus bearing one long seta;

rami of uropod 2 naked; inner ramus of uropod 3 nearly as long as outer; apices of telson acute.

Relationship:

This species is most closely related to *Harpiniopsis profundis* J. L. Barnard, 1960a but differs mainly in the tooth armature on the fifth pereopod, which in *H. profundis* is composed of 2 large teeth below and several small ones above.

Harpinia cinca n. sp.

Material:

St. 101, off Angola, 8°50′S 12°32′E, 990 m, greenish mud, ST 300, 12. XII. 1950. Female, ovigerous, 6 mm.

Vema St. 54, Cape Basin, south Atlantic Ocean, 4680 m. Holotype, female 5.5 mm.

Diagnosis:

Head with medium sized process at lower corner; epistome not produced; article 2 of pereopod 5 produced down to end of article 3, posterior edge with 3 small serrations, below which is a large posteriorly directed tooth followed by a smaller one; lower edge with about 5 serrations; distal anterior edge of article 2 quite expanded and armed with up to 25 large plumose setae; rest of appendage rather short; third pleonal epimeron bearing a medium sized, sligthly upturned tooth at lower corner. Male unkown.

Relationship:

This species resembles *Harpinia latipes* Norman, 1900 (p. 338) in the produced tooth of the third pleonal segment and the expanded setal row of pereopod 5 but differs by the fact that the teeth of pereopod 5 are on the posterior edge of article 2, whereas they are on the ventral edge in *H. latipes*. This species will be figured in Barnard (1961 b).

Except for the longer tooth on the lower part of the head, the Galathea specimen is identical to the type of *H. cinca*. The writer is uncertain of the taxonomic value of this difference and prefers simply to include the specimen under this species without further subspecific partitioning.

Distribution:

Cape Basin, 1861-4680 m; southeastern Atlantic Basin (Angola), 990 m.

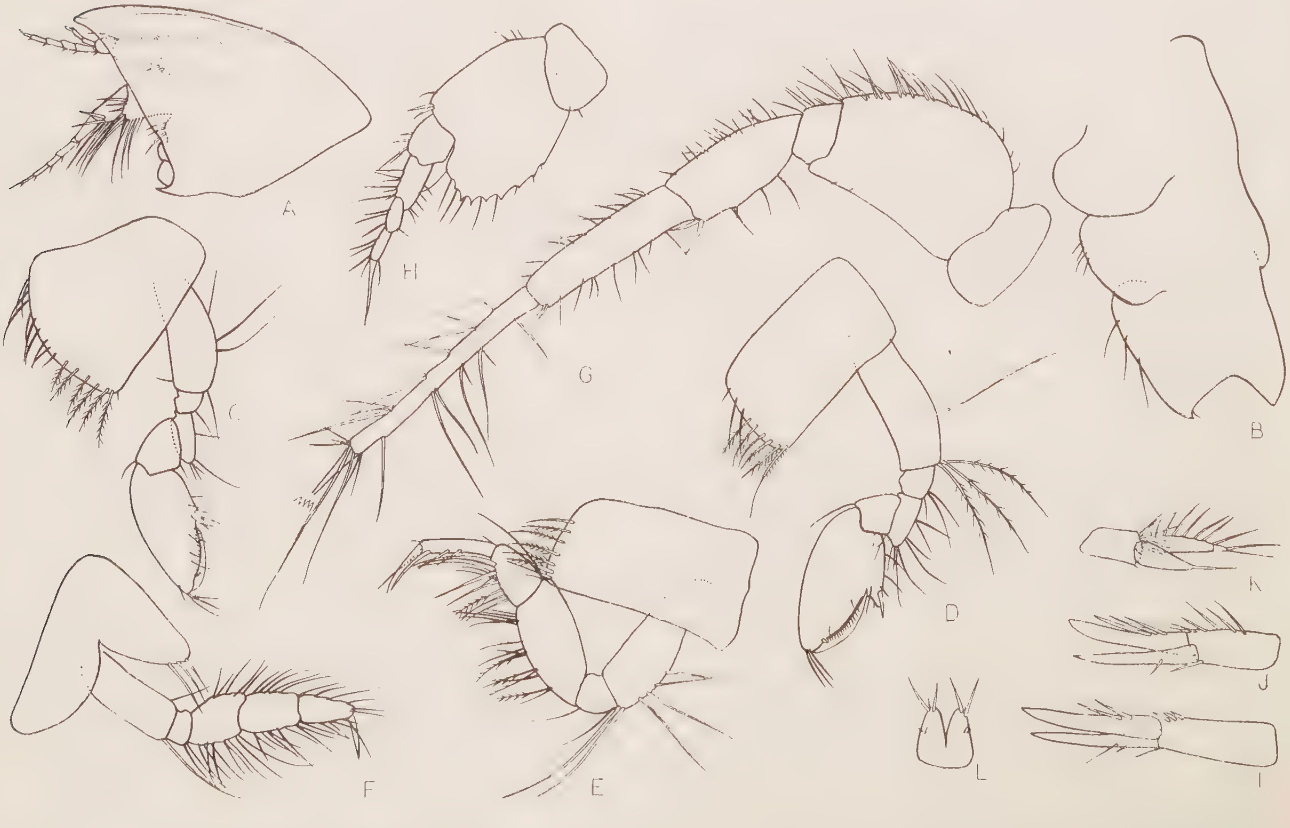


Fig. 40. *Harpinia nadania* n. sp. Female, holotype, 4.25 mm, St. 626. A, head; B, pleon segments 1-3; C, D, gnathopods 1, 2; E, F, G, H, pereopods 1, 3, 4, 5; I, J, K, uropods 1, 2, 3; L, telson.

Harpinia nadania n. sp.

(Fig. 40)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, ST 300, 20. I. 1952. Holotype, female, 4.25 mm. Unique.

Diagnosis:

Head with lower antennal corner bearing an acute, medium-sized process; dorsal surface of head bearing a longitudinal keel; pereopod 4 slender; pereopod 5 rather plain, article 2 with 5 small sharp teeth on posterior edge, lower corner with a pair of large teeth; uropods 1 and 2 with spines on both rami; apices of telson rounded; third pleonal epimeron with straight posterior edge, lower corner with a small tooth.

Relationship:

From *H. abyssalis* Pirlot, 1932 this species differs by the shorter tooth on the third pleonal epimeron and the sharper teeth of pereopod 5.

Harpinia palabria n. sp.

(Fig. 41)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, female, 3.25 mm; figured female, 2.75 mm; 19 other specimens. Total: 21 specimens.

Diagnosis:

Head with acute lower tooth of moderate size; pereopod 4 quite stout for the genus and the basal posterior edge of its second article bearing a cusp, an unusual feature; article 2 of pereopod 5 reaching down to end of article 5, bearing 8 very large acute posterior teeth and a remnant of another; lower anterior edge of article 2 with 4 stout setae but not considered herein as an expanded setal row (see J. L. BARNARD 1960a); article 3 of pereopod 5 with an anterior row of stout setae, another unusual feature; third pleonal epimeron with a large posterior tooth and an oblique lateral row of setae; uropods 1 and 2 with apical setae on the rami; inner ramus of uropod 3 two thirds as long as outer; apices of telson broadly rounded.

Relationship:

This is an unusual species in the several points so noted in the diagnosis. Disregarding the unique features of pereopods 4 and 5 this species bears resemblance to *Harpiniopsis profundis* J. L. Barnard, 1960a, to which it would be keyed in the harpiniid key of p. 345 but differs from it by the uniformly large teeth of pereopod 5, as well as the lateral setae of the third pleonal epimeron. Actually, the species bears a closer resemblance to the north Atlantic *H. latipes* Norman, 1900 (see also CHEVREUX 1927) to which it would be keyed by assuming an expanded anterior setal row on the distal part of article 2 on pereopod 5. The two species are similar in the large teeth of pereopod 5, the teeth on the third pleonal epimeron and head and the anterior setal row of article 3 on pereopod 5. Apparently *H. latipes* lacks the lateral setal row on the third pleonal epimeron and the cusp on pereopod 4.

Heterophoxus oculatus (Holmes, 1908)

Heterophoxus oculatus (Holmes), J. L. BARNARD 1960a: 320-324, pls. 59, 60, 61 (with references).

Material:

St. 743, Gulf of Panama, 7°27′N 79°37′W, 600 m, green clay, PGI 0.2, 16. V. 1952, one specimen.

Distribution:

Widely distributed in the eastern Pacific Ocean from Puget Sound to Panama and with a wide bathymetry, from 10 m to 1920 m. Below about 600 m the species is blind. Its greatest abundance lies between the depths of 80 and 400 m.

Joubinella Chevreux, 1908

Joubinella Chevreux, 1908: 8-11.

The writer believes that no specific distinctions can be made between *Joubinella traditor* Pirlot, 1932 and the type species *J. ciliata* Chevreux, 1908. The distinctions suggested by PIRLOT were weak, as he admitted, and would seem to hinge largely on the third uropod, but I believe from my experience with other Phoxocephalidae (BARNARD 1960a) that the slight differences are due to CHEVREUX' figured specimen being a gerontic female with a tendency for the inner ramus of the third uropod to lengthen in old age.

The two species *J. bychovskii* and *J. strelkovi* (both Gurjanova 1952) seem also to have no specific distinction except in shape of head and rostrum which

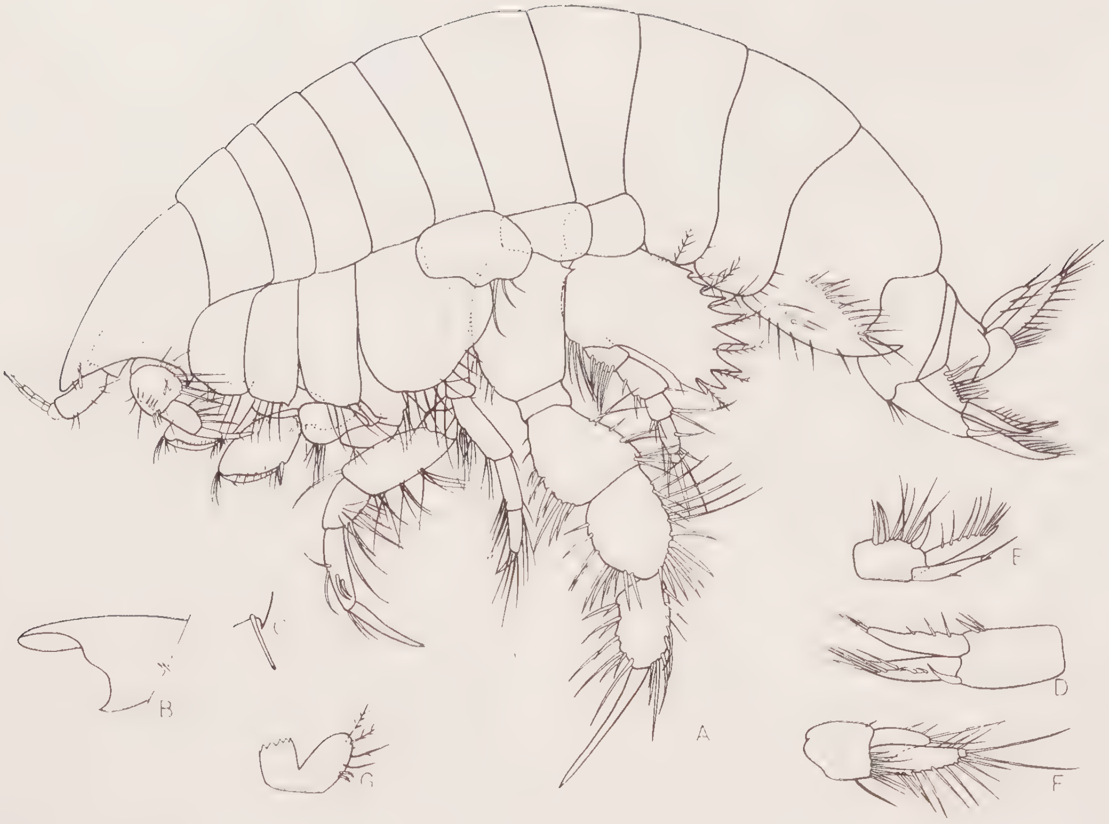


Fig. 41. *Harpinia palabria* n. sp. Female, 2.75 mm, St. 626. A, lateral view; B, head; C, lower corner of coxae 1-3; D, E, F, uropods 1, 2, 3; G, telson.

I believe is simply a variation of a sexual nature, since the two species are based on different sexes.

The two pairs of species *ciliata-traditor* and *bychovskii-strelkovi* differ from each other in the shape of gnathopod 1, which in the first pair has a sharply deflexed distal portion of article 6, not fully developed in the second pair. Another feature of more importance qualitatively is the presence of a large distal peduncular spine on the first uropod in the first pair of species and not in the second.

If this scheme of speciation proves to be correct after further analysis and comparison of materials then the distribution of the species would be a northern Pacific endemic species *(bychovskii-strelkovi)* and a south Pacific-Atlantic species *(ciliata-traditor)*.

Joubinella traditor Pirlot, 1932

Joubinella traditor Pirlot, 1932: 74-81, figs. 19-21.

Material:

St. 554, Great Australian Bight, 37°28′S 138°55′E, 1340-1320 m, Globigerina ooze, ST 300, 5. XII. 1951. Female, 5.5 mm.

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, ST 300, 20. I. 1952. 2 specimens.

Distribution:

Probably a pelagic species. Banda Sea, maximum possible depth 310 m; Tasman Sea, maximum possible depth, 610 m; Great Australian Bight, maximum possible depth 1320-1340 m.

Paraphoxus pyripes K. H. Barnard, 1930

Paraphoxus pyripes K. H. Barnard, J. L. Barnard 1960a: 277 (with synonymy).

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Male, 5 mm; female 5.5 mm. Total: 2 specimens.

Distribution:

Antarctica and north to New Zealand, surface to benthos of 750 m. (Paraphoxids are true burrowers but males often swarm at the surface).

FAMILY HAUSTORIIDAE

Key to the Haustoriidae

1.	Antenna 1 geniculate between articles 1 and 2	2
1.	Antenna 1 not geniculate	3
2.	Gnathopod 2 lacking article 7	*Bathyporeia*
2.	Gnathopod 2 bearing article 7	*Amphiporeia*
3.	Coxa 1 vestigial, less than $^{1}/_{4}$ as long as coxa 3	4
3.	Coxa 1 not vestigial, at least $^{1}/_{2}$ as long as coxa 3	5
4.	Coxa 2 vestigial, less than $^{1}/_{4}$ as long as coxa 3	*Urohaustorius*
4.	Coxa 2 not vestigial, almost as large as coxa 3	*Cardenio*
5.	Pereopod 2 similar to pereopod 3	*Eohaustorius*
5.	Pereopod 2 similar to pereopod 1	6
6.	Coxae 1-2 obtusely pointed below	7
6.	Coxae 1-2 rounded below	9
7.	Articles 4 and 5 of pereopods 4-5, $^{3}/_{4}$ as broad as article 2 of pereopod 5	*Haustorius*
7.	Articles 4 and 5 of pereopods 4-5, $^{1}/_{3}$ as broad as article 2 of pereopod 5	8
8.	Telson split its full length	*Zobracho* n. gen.
8.	Telson split $^{1}/_{3}$ its length	*Priscillina*
9.	Gnathopods chelate	*Platyischnopus*
9.	Gnathopods subchelate	10
10.	Article 5 of first gnathopod subequal to 6 in length	11
10.	Article 5 of first gnathopod 1.5 times longer than 6	12
11.	Articles 4-5 of pereopod 5 grossly expanded	*Haustoriopsis*
11.	Articles 4-5 of pereopod 5 slender	*Pontoporeia*
12.	Inner ramus of uropod 3 scale-like, half as long as outer ramus	*Carangolia*
12.	Inner ramus of uropod 3 subequal to outer	13
13.	Mandibular palp large, on basal process, article 3 subfalcate, molar small, toothed	*Phoxocephalopsis*
13.	Mandibular palp small, directly on mandibular body, article 3 linear, molar large, smooth	14
14.	Article 4 of pereopod 4 not expanded, article 2 of pereopod 5 not greatly produced downward	*Urothoe*
14.	Article 4 of pereopod 4 expanded, article 2 of pereopod 5 greatly produced downward	*Urothoides*

Carangolia n. gen.

Diagnosis:

Mandible very large, bulky; the mandibular triturating surface is large and smooth and lies apically at the cutting edge rather than in the normal molar position; mandibular palp small in relation to the body of the mandible but is triarticulate; antenna 1 not geniculate; pereopods 3-5 slender; coxae 1-4 subequal; uropod 3 small, short, stubby.

Type species: *Carangolia mandibularis* n. sp.

Relationship:

Except for the structure of the mandibles and third uropods this genus resembles *Urothoe* Dana closely.

Carangolia mandibularis n. sp.

Material:

Vema St. 54, Cape Basin, south Atlantic Ocean, 4680 m. Holotype, ?sex, 2.25 mm.

Diagnosis:

Article 2 of pereopod 3 not greatly shortened, evenly lobate and castellate behind; article 2 of pereopod 4 lacking long setae behind; eyes absent; accessory flagellum vestigial.

This species will be figured in BARNARD (1961).

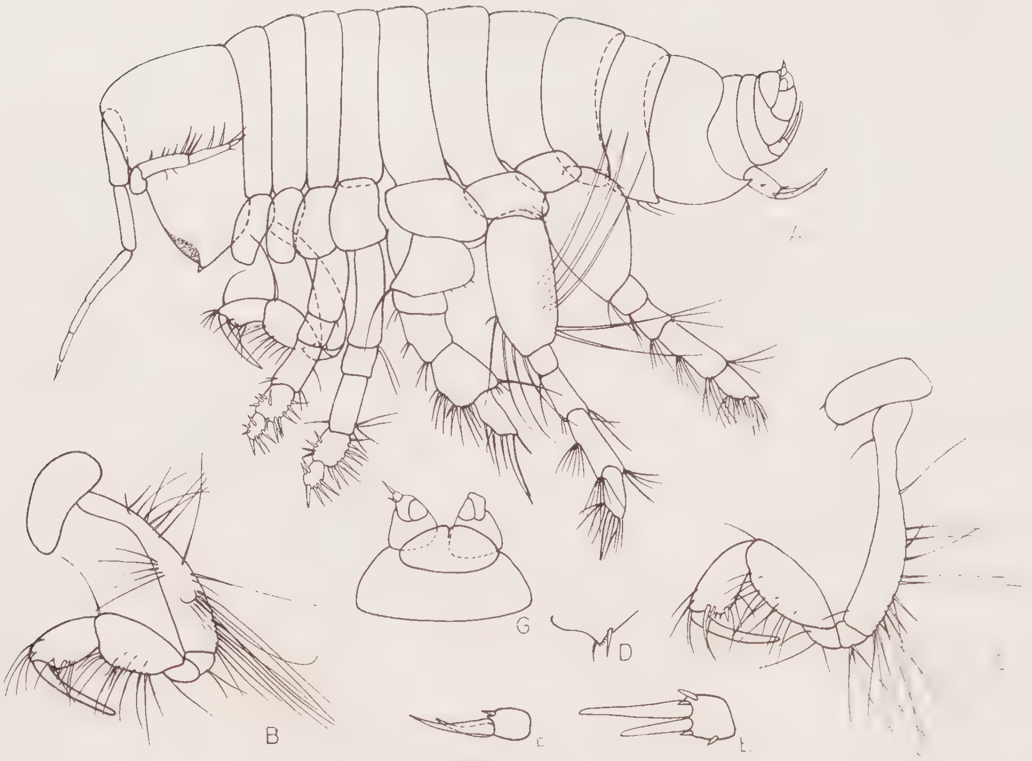


Fig. 42. *Carangolia puliciformis* n. sp. Female, 3 mm, St. 626. A, lateral view; B, C, gnathopods 1, 2; D, palmar corner of gnathopod 1; E, F, uropods 1, 2; G, dorsal view of pleon segment 6 with attached third uropods and telson.

Carangolia puliciformis n. sp.

(Fig. 42)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, ST 300, 20. I. 1952. Holotype, female, 3.5 mm; figured female, 3 mm; dissected female, 3 mm; another specimen 3 mm. Total: 4 specimens.

Diagnosis:

Article 2 of pereopod 3 very short, asymmetrically lobed behind, margin smooth; article 2 of pereopod 4 bearing 5 long setae; eyes and accessory flagellum absent.

Mouthparts similar to the type species, *C. mandibularis* Barnard, 1961.

Relationship:

Differing from the type species only by the points in the diagnosis. The second article of pereopod 3 in *C. mandibularis* bears marginal castellations and pereopod 4 lacks long setae. The palm of gnathopod 2 on *C. puliciformis* lacks the small projection seen on *C. mandibularis*.

Both species resemble fleas, hence the name chosen for the new species.

Zobracho n. gen.

Diagnosis:

Antenna 1 not geniculate; mandibular molar slender, cylindrical; lower lip with well developed mandibular lobes; article 4 of maxillipedal palp blunt apically, setose; coxa 1 evanescent but not vestigial, about one half as long as coxa 3; coxae 1-2 obtusely pointed below; fifth articles of gnathopods more than 1.5 times as long as sixth articles; pereopod 2 like pereopod 1; articles 4 and 5 of pereopods 4 and 5 are about one third as broad as article 2 of pereopod 5; telson split its full length; uropod 3 well developed, setose, inner ramus on female half as long as outer ramus.

Type species: *Zobracho canguro,* n. sp.

Relationship:

The new genus differs from *Priscillina* Stebbing by the fully split telson; from *Haustorius* Muller by the poorly expanded fourth and fifth articles of pereopods 4 and 5 and the presence of mandibular lobes on the lower lip; from *Urothoe* Dana by the pointed first 2 coxae and the smaller mandibular molar; from *Phoxocephalopsis* Schellenberg by the pointed first 2 coxae.

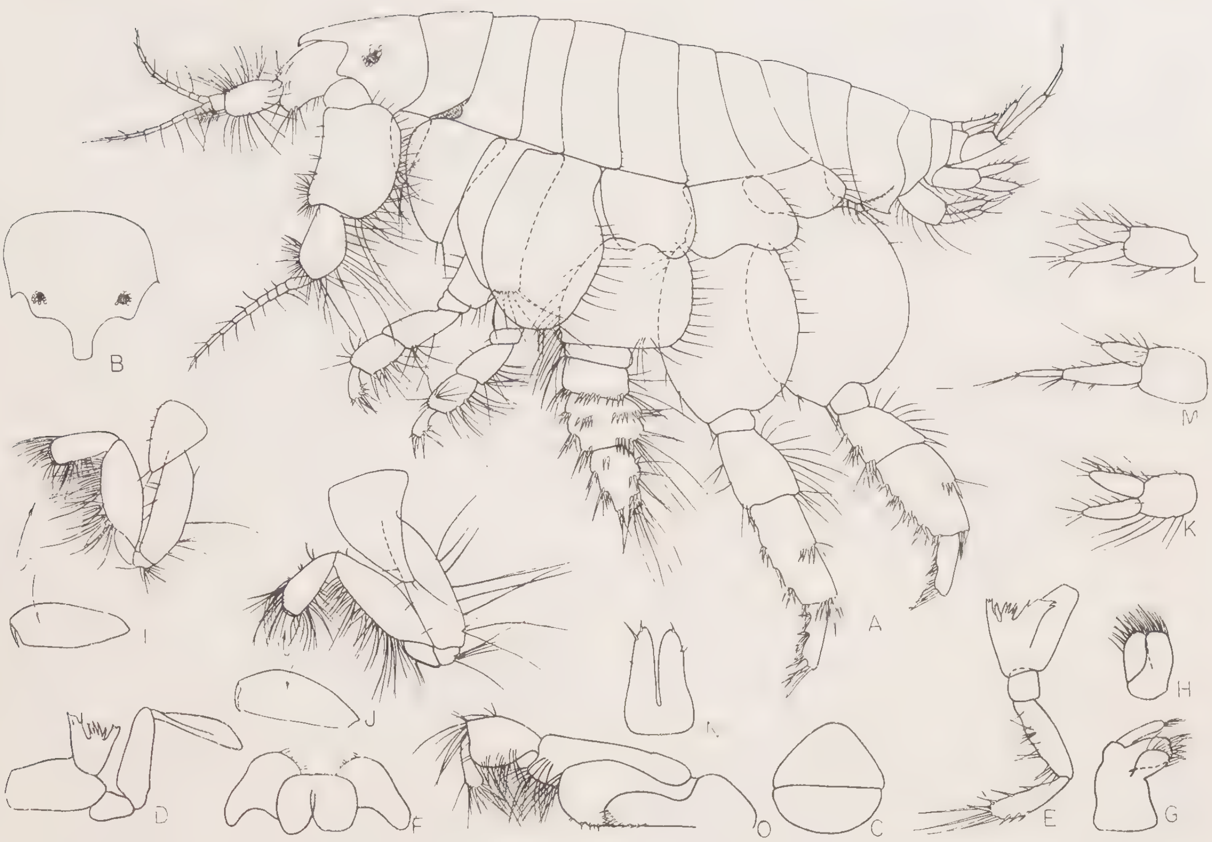


Fig. 43. *Zobracho canguro* n. gen., n. sp. Female, holotype, 5.5 mm, St. 555. A, lateral view; B, head, dorsal view; C, upper lip; D, E, mandibles; F, lower lip; G, H, maxillae 1, 2; I, J, gnathopods 1, 2; K, L, M, uropods 1, 2, 3; N, telson; O, maxilliped.

Zobracho canguro n. sp.
(Fig. 43)

Material:

St. 555, Great Australian Bight, 37°21′S 138°44′E, 875 m, clay, a little sand, PGI 0.2, 6. XII. 1951. Holotype, female, 5.5 mm. Unique.

Diagnosis:

With the characters of the genus.

Eyes composed of a few loosely aggregated ommatidea and a small amount of pigment; rostrum well developed; rami of uropods flat, straight, not deformed; third pleonal epimeron with bulbous hind edge and small, sharp tooth at lower corner.

The inner plate of the first maxilla is attached so as to overlie the outer plate and obscure it from view when examining the attached appendage.

FAMILY LEUCOTHOIDAE

Leucothoe panpulco n. sp.
(Fig. 44)

Material:

St. 716, Acapulco-Panama, 9°23′N 89°32′W, 3570 m, dark muddish clay, HOT, 6. V. 1952. Holotype, female, 9 mm, figured; another specimen 7 mm. Total: 2 specimens.

Diagnosis:

Eyes poorly developed, composed of a small mass of dense tissue; third palp article of mandible more than half as long as second article; article 3 of antenna 1 only one fourth as long as article 1; article 6 of gnathopod 1 exactly twice as long as anterior edge of article 5, finger slender, one fourth as long as article 6; palm of gnathopod 2 minutely dentate, the small projections increasing slightly in size distally; third pleonal epimeron slightly convex behind, sinuous, lower corner quadrate; telson elongate, apex rounded, not ornamented.

Relationship:

The 21 species of the genus *Leucothoe* are not well defined but the present species is distinct from most of them by the poorly developed eyes. It is distinct from the following bathyal or abyssal species: *L. tridens* Stebbing, 1888 bears an apically trifid telson; *L. miersi* Stebbing, 1888 has a markedly shortened third mandibular palp article; *L. rostrata* Chevreux,

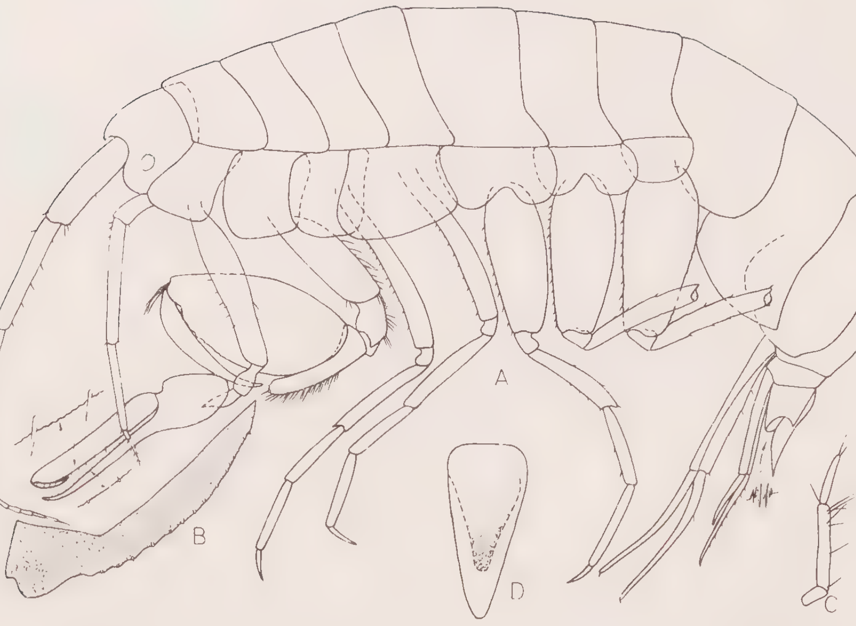


Fig. 44. *Leucothoe panpulco* n.sp. Female, holotype, 9 mm, St. 716. A, lateral view; B, palm of gnathopod 2; C, palp of mandible; D, telson.

1908 has a large rostrum and short telson; *L. uschakovi* Gurjanova, 1951 has a strongly toothed third pleonal epimeron and the third article of the first antenna is more than half as long as article 1. Essentially the new species is a nearly blind *L. spinicarpa* (in SARS 1895: pl. 100, 101, fig. 1) with similar mouthparts, antennae and gnathopods.

The third uropods are missing on both specimens.

FAMILY AMPHILOCHIDAE

Gitanopsis difficilis n. sp.

(Fig. 45)

Material:

St. 555, Great Australian Bight, 37°21′S 138°44′E, 875 m, clay, a little sand, PGI 0.2, 6. XII. 1951. Holotype, ovigerous female, 2.2 mm. Unique.

The single specimen of this new species is in poor condition, having lost the ends of the second antennae, the third uropods and the ends of the pereopods; however, in dissecting the species it was determined that it is clearly unrelated to any other known species and so will be described.

Diagnosis:

Head with rostrum extending to end of first article of antenna 1; a vestigial scale-like accessory flagellum is present; eyes irregularly oval, bleached, not distinguished into dark and light zones; coxa 1 much smaller than coxa 2 and hidden by it; article 2 of gnathopod 1 lacks any basal cusp, anterior edge bearing 3 stout spines; gnathopod 2 with the lobe of article 5 reaching the end of article 6; both gnathopods with expanding, broad sixth articles, palms slightly oblique, microscopically pectinate but not toothed, defined by 2 spines at the corner; article 7 (dactyl) simple, except for one slit-like tooth on the inner edge; pleon segment 3 with straight posterior edge, similar to *G. inermis* Sars, 1895 (pl. 77, fig. 1) with lower corner sharply quadrate; telson cannot be compared with uropod 3, but it is intermediate in length, tapering, and triangular.

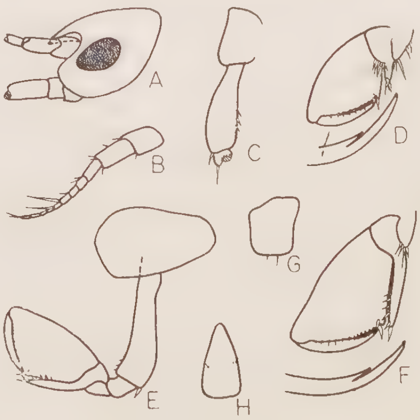


Fig. 45. *Gitanopsis difficilis* n.sp. Female, holotype, 2.2 mm, St. 555. A, head; B, antenna 1; C, basal article of right gnathopod 1; D, end of gnathopod 1; E, gnathopod 2; F, end of gnathopod 2; H, telson.

Relationship:

STEPHENSEN (1949: 6) has provided a key to *Gitanopsis,* in which the present species fits section B, those species with the hind lobe of article 5 on gnathopod 2 reaching to the corner of the palm on article 6. The new species differs from both *G. pusilla* K. H. BARNARD, 1916 (see STEPHENSEN 1949) and *G. tortugae* Shoemaker, 1933 by the more triangular telson, the simple article 7 of both gnathopods, the uniform eyes and other features. The new species is also related to *G. marionis* Stebbing, 1888 (pl. 38) but the gnathopodal palmar articles are more rectangular and expanding and the posterior edge of the third pleonal epimeron is straight, not convex. From *G. inaequipes* Schellenberg, 1926 the new species differs by the less attenuated telson and the much larger and better developed first gnathopod. Finally, from *G. inermis* Sars, 1895 (pl. 77, fig. 1) the species differs by the shorter telson and the uniform eyes. The mouthparts of the new species are identical to those of *G. inermis* and the general body shape, including the coxae fits *G. inermis.*

FAMILY STILIPEDIDAE

Alexandrella dentata Chevreux, 1912
(Fig. 46)

Alexandrella dentata Chevreux, 1912: 134-138, figs. 31-33.

Material:

St. 554, Great Australian Bight, 37°28'S 138°55'E, 1340-1320 m, Globigerina ooze, ST 300, 5. XII. 1951. Female, 9 mm; juvenile 6 mm. Total: 2 specimens.

Remarks:

Except for the shape of the dorsal carina on pleon segment 4 these specimens correspond exactly to Chevreux' excellent description and figures. Neither specimen is in good condition, both having lost the ends of the pereopods and having lost some pieces of uropods but at least one of each part is present on either specimen. The dorsal carina of pleon segment 4 differs from that of CHEVREUX' type by increasing elevation posteriorly rather than being perfectly flat-topped. The writer considers this not of specific value. The young juvenile has the second coxae on both sides of the animal considerably reduced in size when compared with either coxae 1 or 3 but the larger female specimen has coxa 2 as drawn by CHEVREUX.

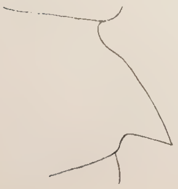


Fig. 46. *Alexandrella dentata* Chevreux. Female, 9 mm, St. 554. Dorsal configuration of pleon segment 4.

Distribution:

Antarctic, Alexander I. Island, 71°S, 297 m; Great Australian Bight, 37°S, 1340-1320 m.

FAMILY PARDALISCIDAE

Arculfia n. gen.

Diagnosis:

Rostrum about half as long as first article of antenna 1, article 2 only half as long as 1, base of primary flagellum long and unsegmented, not inflated; accessory flagellum well developed; cutting edge of mandible smooth on both sides; third mandibular palp article shorter than article 1; upper lip not incised below; lower lip with fused inner lobes; maxilla 2 with setae lining inner edge of inner plate; maxilliped with relatively long articles supporting the small fused inner lobes, article supporting outer plates is short, palp well developed; gnathopod 1 simple, gnathopod 2 with distinct palm; articles 5 and 6 of gnathopods about subequal in length; telson split its full length.

Type species: *Arculfia trago* n. sp.

Relationship:

A key to the Pardaliscidae was provided by J. L. BARNARD (1959a). The presence of an accessory flagellum and the minute third article of the mandibular palp separate the genus from all others in the family, except *Halice* Boeck. It differs from *Halice* only by the subchelate, not simple second gnathopod. The mouthparts project below in a quadrangular assemblage, not conical, unlike *Halicella* Schellenberg, 1926a.

Arculfia trago n. sp.
(Fig. 47)

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, female, 7 mm, ovigerous; and one broken specimen, head end only. Total: 2 specimens.

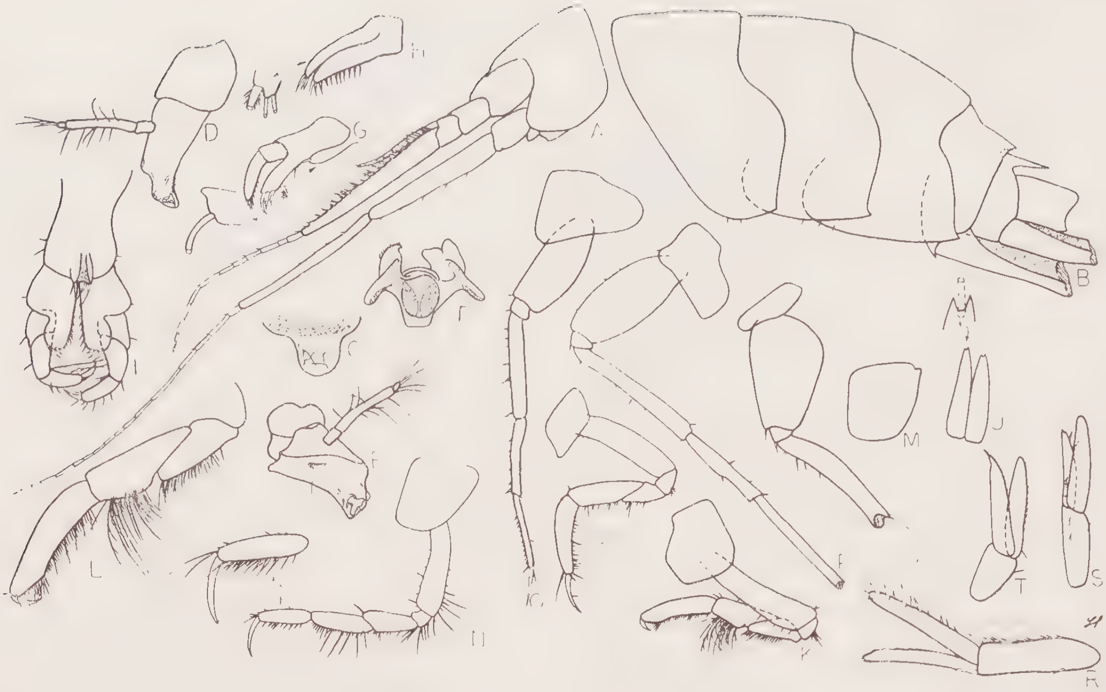


Fig. 47. *Arculfia trago* n. gen., n. sp. Female, holotype, 7 mm, St. 626. A, head; B, pleon; C, upper lip; D, E, mandibles; F, lower lip; G, H, maxillae 1, 2; I, maxilliped; J, K, gnathopods 1, 2; L, gnathopod 2, enlarged; M, coxa 3; N, O, P, Q, pereopods 2, 3, 4, 5; R, S, T, uropods 1, 2, 3; U, telson.

Diagnosis:

With the characters of the genus. Pleonal epimera with convex posterior edges and small points at the lower corners; dorsum of pleon segment 4 with a false tooth covered by a margin of chitin, dorsum of pleon segment 5 with a distinct tooth. Pereopods 1 and 2 have the sixth articles slightly broadened and resemble gnathopods, more so than the first gnathopod of the species.

Pardisynopia n. gen.

Diagnosis:

Head with rostrum extending about half way along the first article of antenna 1; article 2 of antenna 1 half or less as long as article 1; accessory flagellum well developed; base of primary flagellum on antenna 1 slender, segmented; upper lip scarcely incised below; neither right nor left mandible with primary cutting edge toothed; article 3 of mandibular palp of medium length, much longer than article 1; lower lip with inner lobes fused; maxilliped with well developed palp; articles supporting inner and outer lobes not excessively elongated; inner lobes not projecting beyond margin of supporting article; gnathopods 1 and 2 simple, fifth articles subequal or shorter than sixth; articles 4 and 5 of pereopods 1 and 2 inflated, as broad as article 2; telson split to its base.

Type species: *Pardisynopia tambiella,* n. sp.

Relationship:

At first it was considered that this type species could be assigned to the genus *Pardaliscella* since the major differences seem to be the quantitative feature of enlarged articles on the first two pereopods. However, another species of the new genus was discovered in the eastern Pacific Ocean in the *Velero IV* collections (to be published later) that has generic characters identical to the type species and which appears to warrant the erection of a new genus. These features, besides the inflated pereopods, are the fully cleft telson, which in *Pardaliscella* is slit only about half of its length, but especially the smooth, not toothed primary cutting edge of the mandible on both sides. In *Pardaliscella* at least one of the mandibles has a strongly toothed cutting edge. In addition, the inner lobes of the maxilliped are much smaller than in *Pardaliscella* and do not project beyond the margin of the article on which they are borne. The writer believes that these are sufficiently important differences to warrant a new genus, and with the forthcoming *Velero IV* report the genus will be composed of two species.

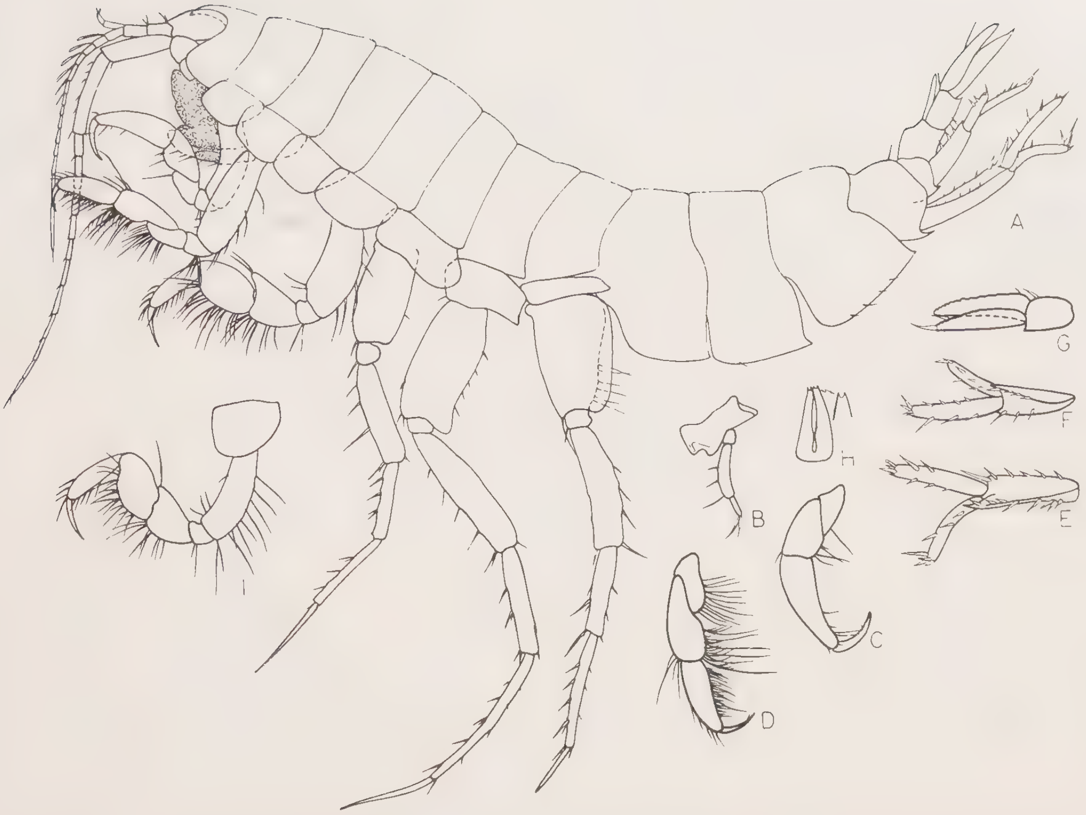


Fig. 48. *Pardisynopia tambiella* n. gen., n. sp. Female, holotype, 4 mm, St. 626. A, lateral view; B, mandible; C, D, gnathopods 1, 2; E, F, G, uropods 1, 2, 3; H, telson; I, pereopod 1.

Notes:

The new genus *Pardisynopia* poses some problems concerning amphipod classification, which involve the family Synopiidae and the possibility that its members do not deserve family status.

The genus *Pardisynopia* is unique in the family Pardaliscidae for its stout first and second pereopods. This case has a parallel in the genus *Synopia* Dana which has familial status because of its stout first and second pereopods. Except for this character *Synopia* would belong to the Tironidae where it is closely related to *Tiron* by its accessory eyes. The writer believes that these two cases, in closely related families (Tironidae and Pardaliscidae) should be treated with parallel decisions. If history were repeated then the new genus should be used as the type of a new family and the otherwise close relationship to Pardaliscidae would be obscured. On the other hand, the writer believes that the Synopiidae do not deserve family rank and should be submerged in the Tironidae.

Pardisynopia tambiella n. sp.
(Fig. 48)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, ovigerous female, 4 mm. Unique.

Diagnosis:

Article 2 of pereopod 4 with a lobe at lower posterior corner; pleonal epimera all with a distinct small tooth at the lower corners.

Relationship:

Only the two characters of the diagnosis above will separate this species from the second to be described in a forthcoming paper. In addition, the sixth coxa has a small posterior tooth but I am not certain that part of its configuration was not due to damage.

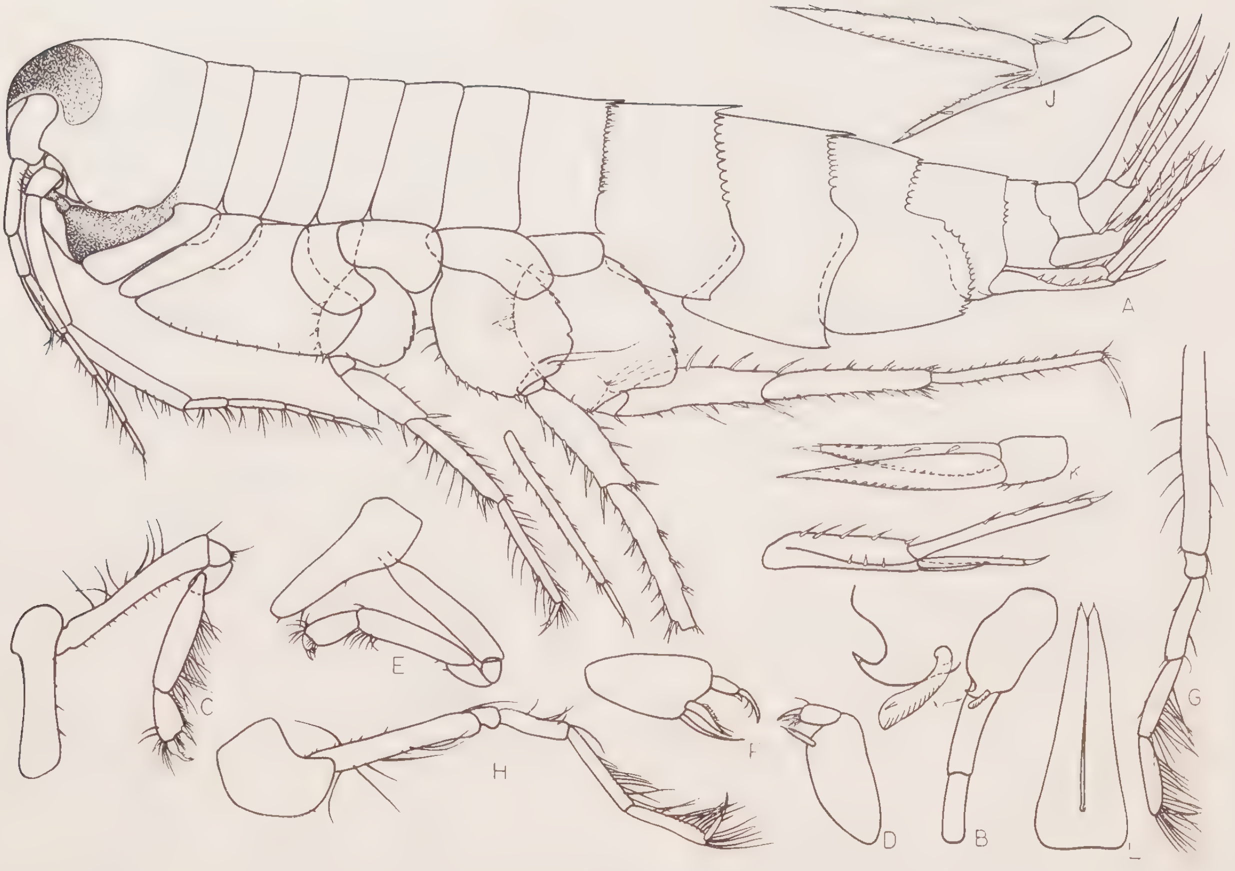


Fig. 49. *Syrrhoe ?affinis* Chevreux. Female, 7 mm, St. 626. A, lateral view; B, antenna 1; C, D, gnathopod 1; E, F, gnathopod 2; G, H, pereopods 1, 2; I, J, K, uropods 1, 2, 3; L, telson.

FAMILY TIRONIDAE

Syrrhoe ?affinis Chevreux, 1908
(Fig. 49)

Syrrhoe affinis Chevreux, 1908: 7-9, fig. 4; Sexton 1911: 202-207, pl. 3, figs. 1-8; Chevreux 1927; 86, pl. 7, fig. 27; Chevreux 1935: 98, pl. 13, fig. 7.

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, ST 300, 20. I. 1952. Female, 7 mm; young male, 7 mm; specimen 6.5 mm. Total: 3 specimens.

Diagnosis:

Eyes apparently absent but head possessing an area composed of cellular material not organized into ommatidea; article 2 of pereopods 3-5 only sparsely and minutely toothed; dorsal posterior margins of pereon segment 7 and pleon segments 1-3 sharply serrate, with a dorsal tooth on pereon segment 7 and pleon segments 1-2; posterolateral margin of pleon segment 4 serrate and pleon segment 5 bears one serration; posterior margin of third pleonal epimeron serrate, with a smooth margin between it and dorsal margin; medial distal margin of article 1 on antenna 1 with an unciform tooth and accessory laminiform process. Mouthparts like *S. crenulata* (in Sars 1895: pl. 136).

Relationship:

This species differs from *Syrrhoe semiserrata* Stebbing, 1888 (pl. 51) by the dorsal serrations of pereon segment 7 and pleon segments 1-4.

It differs from *S. crenulata* Goes by the less deeply serrate second article of pereopods 3-5, the gap in the serrations on the third pleonal epimeron and the shorter sixth article of gnathopod 2.

From *S. psychrophila* Monod, 1926 (Schellenberg 1931 and K. H. Barnard 1932) it differs only by the minor feature of the shorter sixth article on gnathopod 2. Perhaps the serrations of pleon segment 4 have been overlooked in *S. psychrophila*.

The wide geographic separation of the present locality and that of the north Atlantic Ocean for the type casts doubt on the validity of specific concepts in this genus and suggests that *S. crenulata* var. *psychrophila* Monod, 1926 (= *S. psychrophila* by SCHELLENBERG 1931 and K. H. BARNARD 1932) is the same as *S. affinis* and the present specimens, and that these are varieties of *S. crenulata*. Several discrepancies must be cleared up: *S. affinis* and the present specimens lack eyes; the specimens at hand have an accessory process in the form of an articulated laminiform tooth on antenna 1; *S. affinis* and the present specimens have short sixth articles on gnathopod 2; the present specimens have serrations on pleon segments 4 and 5 which may have been overlooked in previous material, because they are very difficult to see. Actually, the shape of the second gnathopod may be the important specific feature.

Distribution:

Originally described from the north Atlantic Ocean off Morocco, 460-888 m; west of the English Channel, 440 m.

FAMILY OEDICEROTIDAE

Key to the Oedicerotidae

This key attempts to minimize the use of eyes. Nevertheless, several genera cannot remain separate without some reference to eyes, as seen in the last part of the key.

1. Gnathopod 2 chelate 2
1. Gnathopod 2 subchelate 3
2. Mandibular molar normal .... *Pontocrates*
2. Mandibular molar degraded .... *Synchelidium*
3. Primary plate of mandible short, not projecting, untoothed 4
3. Primary plate of mandible projecting, toothed 6
4. Gnathopod 2 with posterior lobe of article 5 guarding article 6 5
4. Gnathopod 2 with posterior lobe of article 5 projecting at right angles, not guarding article 6 .... *Westwoodilla* and *Bathymedon*
5. "Mandibular palp article 2 strongly curved" .... *Arrhis*
5. "Mandibular palp article 2 straight" .... *Aceroides*
6. Uropod 2 reaches only to end of peduncle of uropod 3 7
6. Uropod 2 reaches $^3/_4$ along rami of uropod 3 8
7. Gnathopods 1 & 2, article 5 strongly lobate .... *Halicreion*
7. Gnathopods 1 & 2, article 5 not lobate .... *Parhalimedon*
8. Mandible lacking palp .... *Metoediceros*
8. Mandible bearing palp 9
9. Mandibular molar lacking triturating surface 10
9. Mandibular molar bearing teeth and ridges 15
10. Mandibular molar small, leaf-like, produced into a spine, coxa 4 produced acutely behind *Exoediceropsis*
10. Mandibular molar bulbous or cylindrical, coxa 4 not produced behind 11
11. Lower lip, inner lobes fused 12
11. Lower lip, inner lobes separate 13
12. Telson entire .... *Perioculodes*
12. Telson emarginate .... *Perioculopsis*
13. Gnathopods 1-2 structurally alike 14
13. Gnathopods 1-2 structurally dissimilar .... *Paroediceros*
14. Gnathopods 1 & 2, lobe of article 5 long, guarding article 6 .... *Arrhinopsis*
14. Gnathopods 1 & 2, lobe of article 5 short, not guarding article 6 .... *Oediceros*
15. Gnathopod 1, palm transverse .... *Carolobatea*
15. Gnathopod 1, palm oblique 16
16. Gnathopods 1 and 2, article 5 not distinctly lobate 17
16. Gnathopods 1 and 2, article 5 grossly lobate 19
17. Gnathopod 2 subchelate 18

17. Gnathopod 2 simple .... *Bathyporeiapus*
18. Eyes unpaired, fused; base of pereopod 5 broadly lobed distally .... *Methalimedon*
18. Eyes paired; base of pereopod 5 sharply narrowed distally .... *Parhalimedon*
19. Back multicarinate .... *Acanthostepheia*
19. Back not multicarinate, usually smooth, occasionally tuberculate 20
20. Coxa 4 produced acutely backward distally .... *Paroediceroides*
20. Coxa 4 not produced backward distally 21
21. Pereopods 1-2, article 7 absent .... *Exoediceros*
21. Pereopods 1-2, article 7 present 22
22. Eyes completely fused 23
22. Eyes separated by a median line or space or absent 24
23. Eyes forming a semicircular ring .... *Gulbarentsia*
23. Eyes forming a circle or oval .... *Paraperioculodes*
24. Gnathopod 2, lobe of article 5 projecting erectly at 90°, not guarding article 6 25
24. Gnathopod 2, lobe of article 5 projecting forward distally at angle of 45° or less, guarding article 6 28
25. Eyes lateral .... *Oediceropsis*
25. Eyes contiguous at midline or absent 26
26. Maxilla 2, outer plate lacking stout spine 27
26. Maxilla 2, outer plate bearing stout spine .... *Anoediceros*
27. Basal portion of flagellum on antenna 2 swollen .... *Lopiceros* n. gen.
27. Basal portion of flagellum on antenna 2 slender .... *Oediceroides* and *Oediceropsoides*
28. Antenna 1 longer than antenna 2 .... *Monoculopsis*
28. Antenna 1 not longer than antenna 2 .... *Monoculodes*

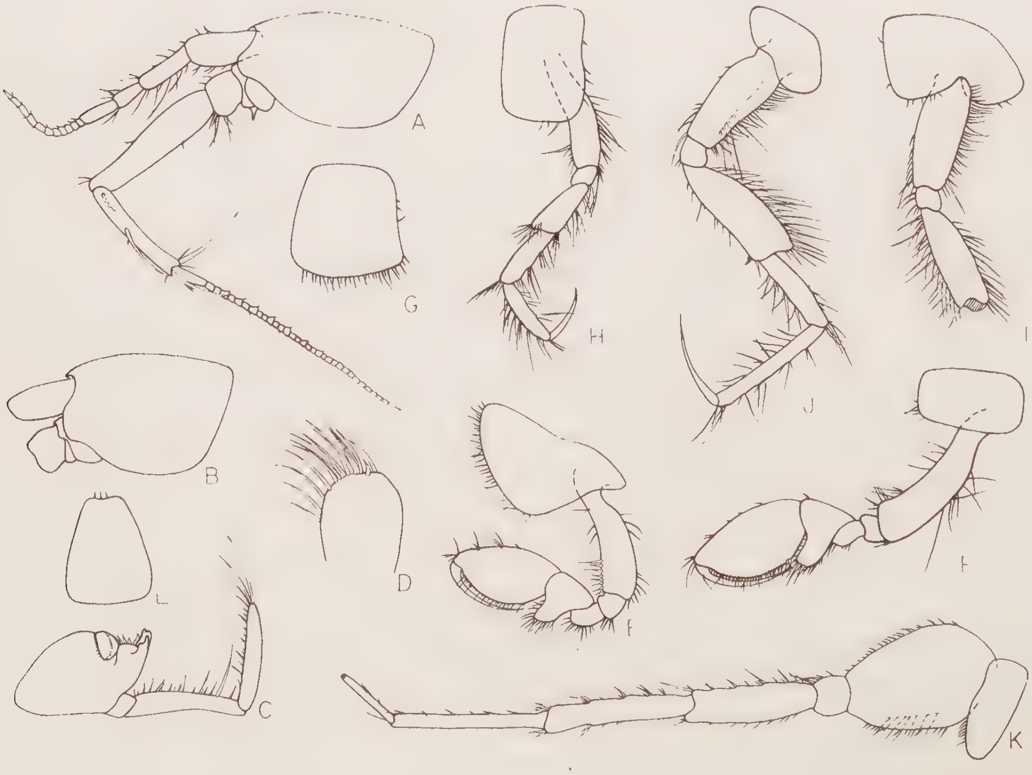
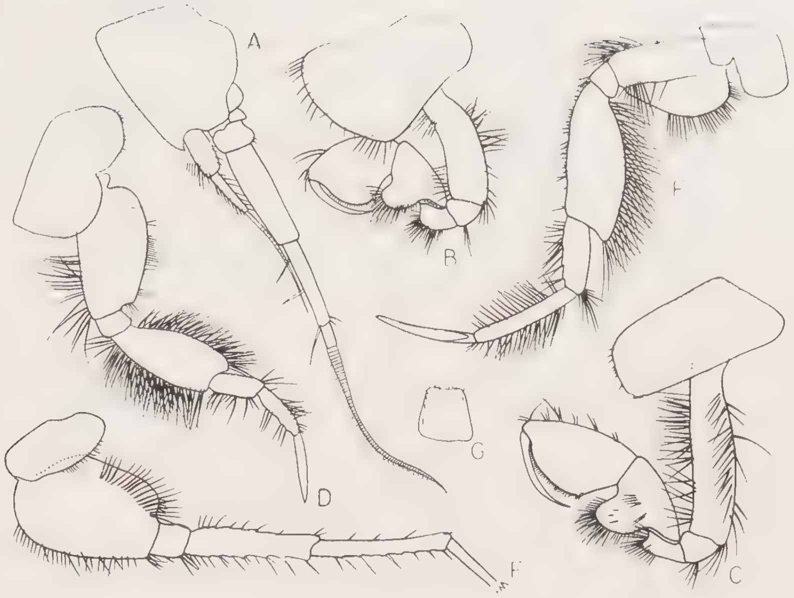


Fig. 50. *Anoediceros hanseni* Pirlot. ?Male, 6 mm, St. 557. A, B, head, two views; C, mandible; D, outer plate of maxilla 2; E, F, gnathopods 1, 2; G, coxa 4; H, I, J, K, pereopods 1, 3, 4, 5; L, telson.

Fig. 51. *Anoediceros hanseni mozambis* n. subsp. Female, holotype, 24 mm, St. 238. A, head; B, C, gnathopods 1, 2; D, E, F, pereopods 3, 4, 5; G, telson.



Anoediceros hanseni Pirlot, 1932
(Fig. 50)

Anoediceros hanseni Pirlot, 1932: 82-87, figs. 22-25.

Material:

St. 557, Great Australian Bight, 37°13'S 138°42'E, 680 m, clay, PGI 0.2, 6. XII. 1951. ?Male, 6.5 mm.

Remarks:

The present specimen appears relatively similar to PIRLOT's species but differs in several small respects which may be problems of drawing, mutilation of specimen and wear. The lateral head lobes of the present specimen project more than in PIRLOT's drawing. The 5th peduncular article of the second antenna bears 3 large spines, not drawn by PIRLOT but possibly broken off in his specimen. The outer plate of the second maxilla bears a stout but unfurcated spine, while PIRLOT showed a bifurcated one. Probably age or wear accounts for this discrepancy.

Anoediceros hanseni mozambis n. subsp.
(Fig. 51)

Anoediceros hanseni Pirlot, 1932: 82-87, figs. 22-25.

Material:

St. 238, off Kenya, 3°23'S 44°04'E, 3960 m, Globigerina ooze, HOT, 13. III. 1951. Holotype, female, 24 mm; and one female, 23 mm. Total: 2 specimens, white in life.

Diagnosis:

Differing from the typical subspecies by the slightly longer fifth article of gnathopods 1 and 2, its slightly less produced posterior lobe; the second article of the fourth pereopod is more expanded proximally. All other parts correspond with PIRLOT's drawings.

Remarks:

The telson of the new subspecies is slightly emarginate but this condition is not apparent in the same position as drawn by PIRLOT (fig. 25) when it is attached to the urosome. The spine defining the palms of both gnathopodal pairs is much shorter than for PIRLOT's material. The typical subspecies came from the Ceram Sea, Indonesia, 835 m.

Bathymedon Sars, 1895

The criterion separating *Bathymedon* from *Westwoodilla* Bate is relatively insignificant. It is based on the straight second mandibular palp article of *Bathymedon* as opposed to the curved condition in *Westwoodilla*. Not all specimens of a species have this article uniformly curved or uniformly straight and certain species seem to be intermediate. Most species of *Bathymedon* have lost the eyes or have them strongly reduced and the rostra are less robust or almost totally absent in contrast to most species of *Westwoodilla*. It is still useful to retain *Bathymedon* as a genus, representing deep sea species, although it is probable that it is polyphyletic and unnatural.

Key to Bathymedon

1.	Epistome conically produced	*covilhani* n. sp.
1.	Epistome rounded in front	2
2.	Article 6 of gnathopod 2 much longer than article 5	*saussurei*
2.	Article 6 of gnathopod 2 equal to or shorter than article 5	3
3.	Telson distinctly emarginate	4
3.	Telson apically rounded or truncate	6
4.	Rostrum evanescent, blunt, not projecting beyond lateral lobes	*palpalis*
4.	Rostrum acute, projecting well beyond lateral lobes	5
5.	Eyes absent	*acutifrons*
5.	Whitish eyes present	*longimanus*
6.	Article 3 of first antenna 1.5 times as long as article 1, rostrum totally absent	*gorneri*
6.	Article 3 of first antenna equal to or shorter than article 1, rostrum present	7
7.	Head margin vertical below lateral corner	8
7.	Head margin oblique below lateral corner	9
8.	Palm of gnathopods longer than hind margin of article 6	*candidus* n. sp.
8.	Palm of gnathopods shorter than hind margin of article 6	*langsdorfi*
9.	Article 5 of gnathopod 1 with indistinct hind lobe	10
9.	Article 5 of gnathopod 1 with distinct hind lobe	11
10.	Article 6 of gnathopod 2 shorter than article 5	*tilesii*
10.	Article 6 of gnathopod 2 subequal to article 5	*subcarinatus*
11.	Article 7 of gnathopod 2 half as long as article 6	*ivanovi*
11.	Article 7 of gnathopod 2 nearly as long as article 6	12
12.	Palm of gnathopod 1 shorter than hind margin of article 6, rostrum acute	*nanseni*
12.	Palm of gnathopod 1 as long as hind margin of article 6, rostrum blunt	*obtusifrons*

Bathymedon candidus n. sp.
(Fig. 52)

Material:

St. 453, Makassar Strait, 3°56′S 118°26′E, 2000 m, greenish clay, ST 300, 24. VIII. 1951. Holotype, female, 6.5 mm. Unique.

Diagnosis:

Eyes absent, rostrum very small; peduncle of antenna 1 short, articles stout, articles 2 and 3 each shorter than article 1; article 5 of gnathopod 1 shorter than article 6, bearing a broad lobe which points slightly distally; article 5 of gnathopod 2 equal in length to article 6, hind lobe slightly more defined than on gnathopod 1 and similar in shape; palm of gnathopods longer than hind margin of article 6; coxa 1 not strongly produced forward; article 2 of pereopod 4 slender; pleon segment 4

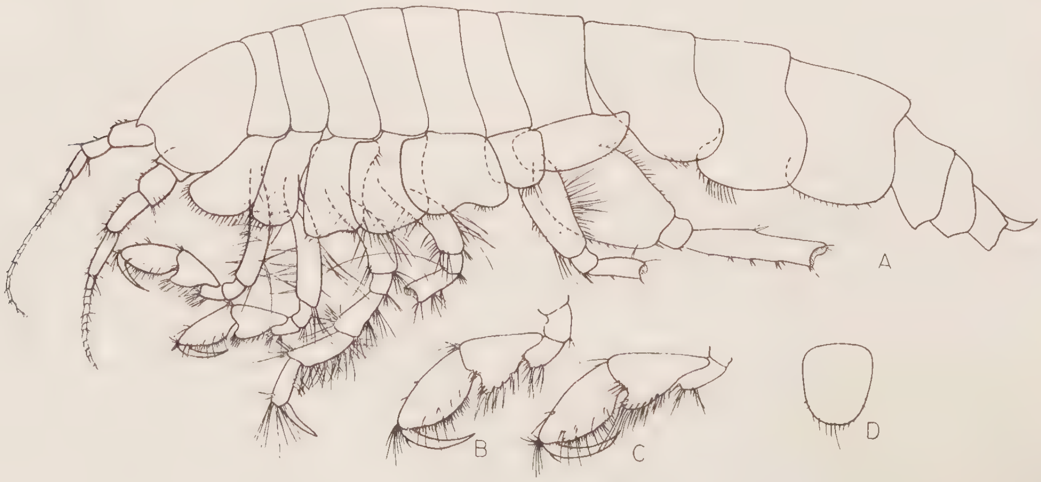
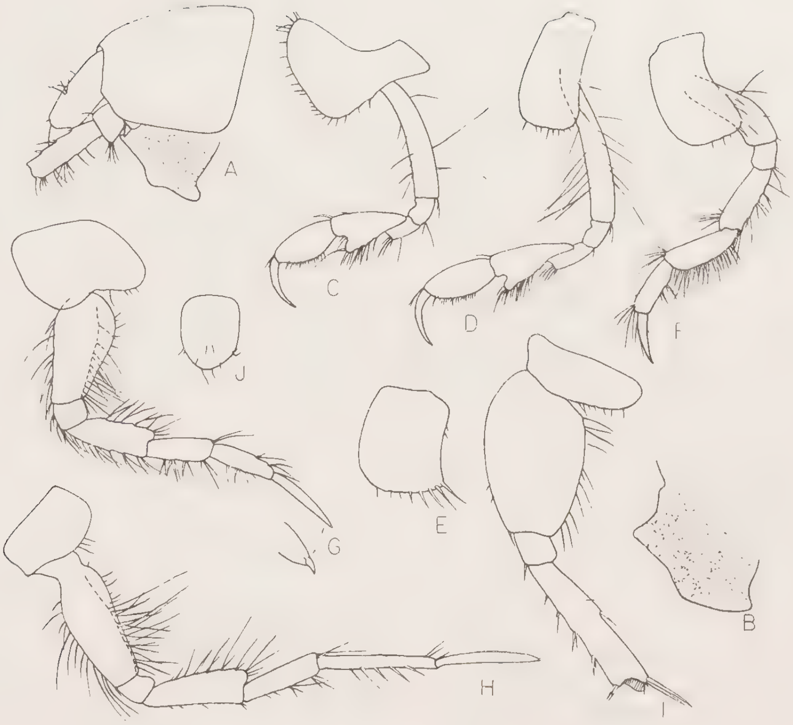


Fig. 52. *Bathymedon candidus* n. sp. Female, holotype, 6.5 mm, St. 453. A, lateral view; B, C, gnathopods 1, 2; D, telson.

Fig. 53. *Bathymedon covilhani* n. sp. ?Male, holotype, 6 mm, St. 745. A, head; B, epistome; C, D, gnathopods 1, 2; E, coxa 4; F, G, H, I, pereopods 1, 3, 4, 5; J, telson.



armed dorsally only with a seta; lower front edge of second pleonal epimeron strongly setose; telson apically rounded.

Mouthparts like *B. longimanus* (in SARS 1895: pl. 117).

Relationship:

Differing from *Bathymedon palpalis* K. H. Barnard, 1916, which it superficially resembles by many features: the stouter first antenna with shorter articles; the similarity of gnathopod 2 to gnathopod 1, whereas in *B. palpalis* gnathopod 2 has article 5 relatively longer than on gnathopod 1; the rounded, not emarginate telson; the lack of stout dorsal spines on pleon segment 4, and the setosity of the second pleonal epimeron.

Bathymedon candidus is related to *B. langsdorfi* Gurjanova, 1951 by the vertical anterior margin of the lateral head lobe but differs by the longer palms of the gnathopods and the smaller rostrum.

Bathymedon covilhani n. sp.
(Fig. 53)

Material:

St. 745, Gulf of Panama, 7°15′N 79°25′W, 915 m, green clay, ST 600, 16. V. 1952. Holotype, ?male, 6 mm. Unique.

Diagnosis:

Eyes absent; rostrum obsolete; epistome conically produced in front; coxa 1 markedly produced forward, first 3 coxae with stout spines on posterior edges; article 5 of gnathopods having the hind lobe detached distally from the hind margin; telson rounded apically.

Mouthparts and first 2 uropods typical of *Bathymedon longimanus* (in SARS 1895: pl. 117). Except for basal articles the antennae are missing. The third uropods are missing. The gnathopodal palms lack defining spines.

Relationship:

It is probable that this species should form the type of a new subgenus assignable to *Bathymedon,* for the produced epistome is unique, perhaps among all Oedicerotidae. Until a firmer base can be made for the distinction of *Bathymedon* from *Westwoodilla,* the writer hesitates in creating the new subgenus.

Superficially the new species resembles *B. palpalis* K. H. Barnard, 1916 by its blunt head but differs by the rounded, not emarginate telson. It resembles *B. gorneri* Gurjanova, 1951, but differs by the detached hind lobes on the fifth articles of the gnathopods.

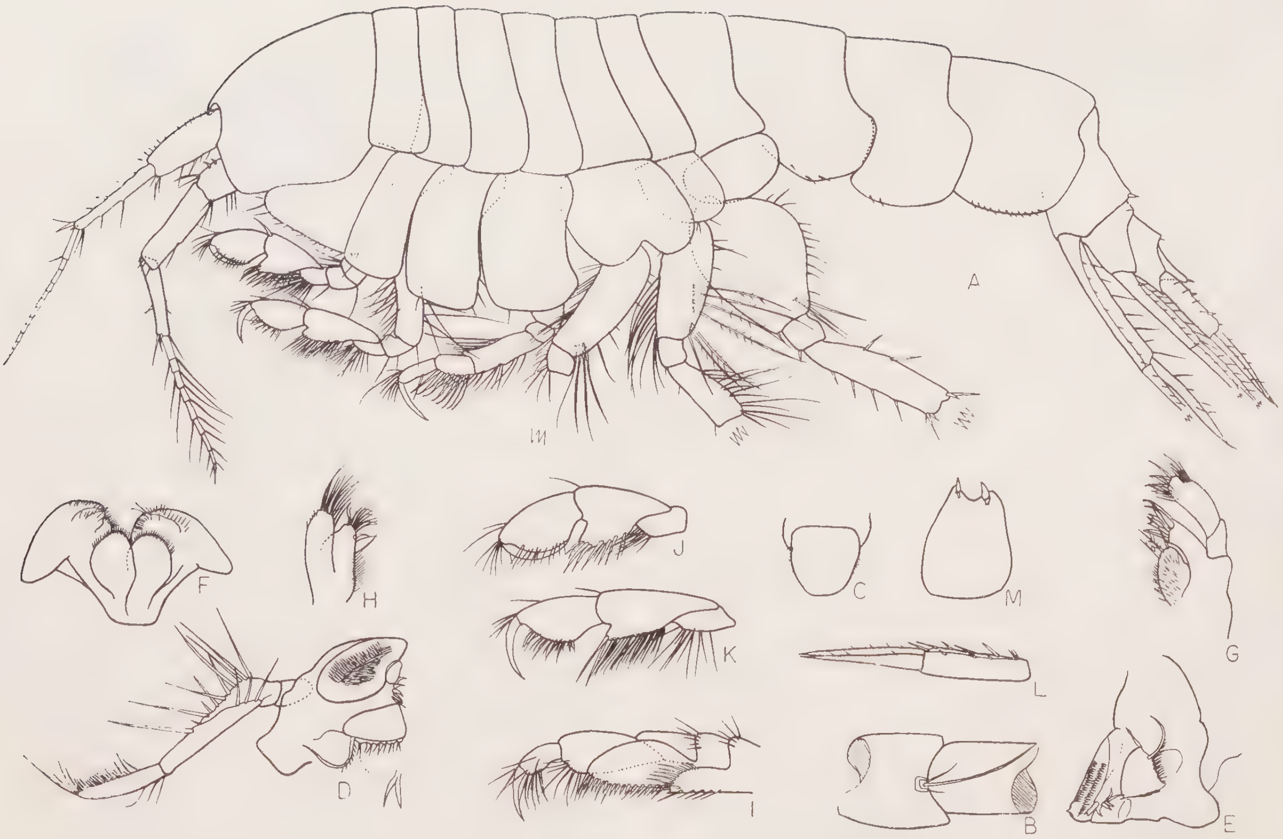


Fig. 54. *Bathymedon palpalis* K. H. Barnard. Female, 7 mm, St. 101. A, lateral view; B, accessory flagellum on antenna 1, enlarged; C, upper lip; D, E, mandibles; F, lower lip; G, H, maxillae 1, 2; I, maxilliped; J, K, gnathopods 1, 2; L, uropod 3; M, telson.

Bathymedon palpalis K. H. Barnard, 1916
(Fig. 54)

Bathymedon palpalis K. H. Barnard, 1916: 163-165, pl. 27, figs. 1-3.

Material:

St. 101, off Angola, 8°50'S 12°32'E, 990 m, greenish mud, ST 300, 12. XII. 1950. Figured female, ovigerous, 7 mm and 2 mutilated specimens; total 3 specimens.

Diagnosis:

Eyes absent, rostrum very small; peduncle of first antenna long, slender, article 2 subequal to article 1, article 3 much shorter than 1; article 5 of gnathopod 1 slightly longer than article 6, bearing a broad posterior lobe; article 5 of gnathopod 2 much longer than article 6, posterior lobe shallower than on first gnathopod, palm of gnathopods longer than hind margin of article 6; coxa 1 produced forward strongly; pereopods 3-4 with article 2 slender; pleon segment 4 with a pair of stout dorsal spines; telson emarginate, each lobe with a stout spine.

Remarks:

The present specimens fail to answer K. H. BARNARD's description in the first antenna, where article 2 of the peduncle is as long as article 1, otherwise there is close agreement. The denticles of pleon segment 4 are described herein and the third uropod figured. Antenna 1 bears a very minute accessory flagellum, as drawn.

Distribution:

Recorded by K. H. BARNARD from off Cape Point, South Africa, 650 fms (1190 m).

Monoculodes Stimpson, 1853

The type and most of the species of *Monoculodes* are distinguishable from *Oediceroides* by the fifth article of the second gnathopod which is slender and curved or geniculated distally to guard article 6; however, a few species, best represented by *M. latissimanus* Stephensen, 1931 have this lobe unmodified and short, not guarding the sixth article so that it is problematical as to what genus STEPHENSEN's species might belong. However, all species

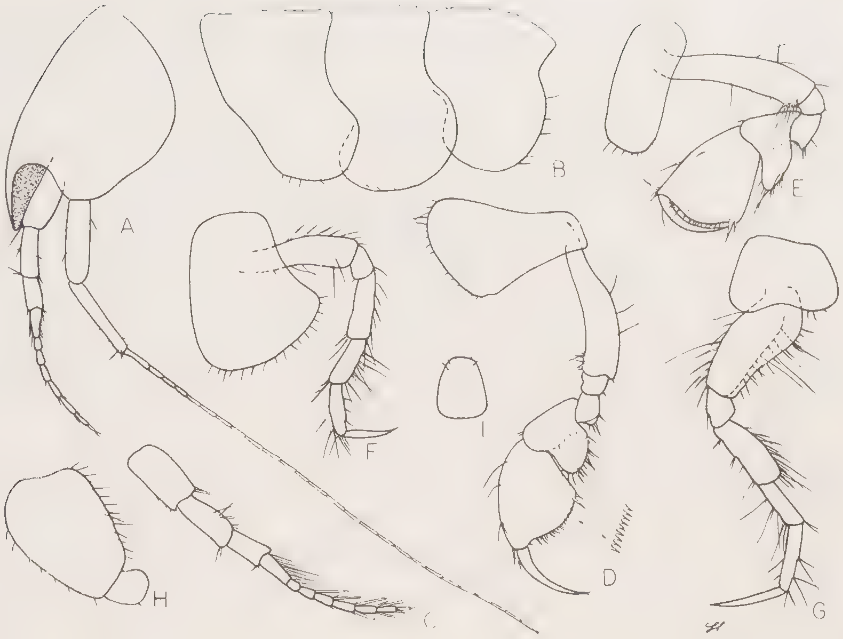


Fig. 55. *Monoculodes abacus* n. sp. ?Male, holotype, 4 mm, St. 626. A, head; B, pleon segments 1-3; C, antenna 1; D, E, gnathopods 1, 2; F, G, H, pereopods 2, 4, 5; I, telson.

of *Oediceroides* which the writer has been able to check microscopically or in the literature have uniform gnathopods and specific differences in gnathopods are of no value in that genus. On the other hand the gnathopods are of major importance in *Monoculodes* for specific criteria and because the variations are rampant it is the writer's belief that the atypical stout gnathopods of *M. latissimanus* represent evolution within the genus *Monoculodes* and not *Oediceroides*.

Monoculodes abacus n. sp.

(Fig. 55)

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, male?, 4 mm.

Diagnosis:

Eyes absent, rostrum nearly straight, tapering acutely, reaching to end of first peduncular article of antenna 1; sixth or palmar articles of gnathopods very stout, broad, palms nearly transverse; lobe of fifth article on gnathopod 1 stout, short, blunt, reaching slightly more than halfway along article 6, lobe on gnathopod 2 more slender but reaching only halfway along article 6; article 7 of pereopods 1 and 2 as long as article 6; telson with apex slightly convex, spinules small. The uropods and pereopods are largely broken.

Relationship:

The differences between the genera *Oediceroides* and *Monoculodes* are strongly intergraded in some species such as *Monoculodes latissimanus* Stephensen, 1931, to which the new species *M. abacus* is most closely related; however, *M. abacus* more apparently belongs to *Monoculodes* because the lobe on the fifth article of gnathopod 2 projects slightly distalwards. The rostrum of *M. abacus* is slightly longer and much more conspicuous than in *M. latissimanus* and the telson is slightly convex and armed with small, not large spinules. This species might be keyed to *M. diamesus* Gurjanova (GURJANOVA 1951) but the head, rostrum, and shapes of articles 5 and 6 on gnathopods 1 and 2 are quite distinctive. In *M. diamesus* the lateral head lobes are quite acute and the lobes of the gnathopods are distinctly geniculate.

Genus **Oediceroides** Stebbing, 1888

Oediceroides Stebbing, 1888: 843.
Oediceropsoides Shoemaker, 1925: 27.

Diagnosis:

Mandible with projecting primary cutting teeth; mandibular molar bearing teeth and ridges; mandibular palp present; gnathopodal pairs of similar structure, subchelate, palms oblique, hind lobe of fifth article perpendicular to anterior surface, not guarding article 6; posterior corner of coxa 4 not

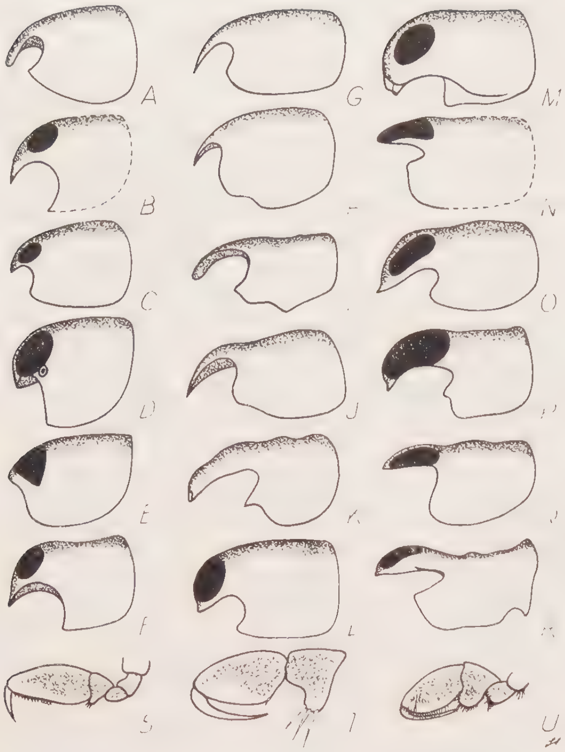


Fig. 56. Taxonomic illustrations of species in the genus *Oediceroides*, largely based on head morphology. Gnathopods of all species are like Fig. U except for *O. zanzabaricus* in Fig. T, and *O. microcarpus* in Fig. S.

Heads: A, *O. similis* Nicholls, 1938; B, *O. pirloti* Sheard, 1936; C, *O. calmani* Walker (Chevreux 1912); D, *O. cystifera* Schellenberg, 1931; E, *O. brevirostris* Schellenberg, 1931; F, *O. newnesi* (Walker, 1903); G, *O. weberi* Pirlot, 1932; H, *O. wolffi* n. sp.; I, *O. abyssorum* (Shoemaker, 1925); J, *O. limpieza* n. sp.; K, *O. rostratus* (Stebbing, 1888); L, *O. macrodactylus* Schellenberg, 1931; M, *O. ornithorhynchus* Pirlot, 1932; *O. cinderella* Stebbing, 1888; P, *O. apicalis* K. H. Barnard, 1931 (new figure); Q, *O. ornatus* (Stebbing, 1888); R, *O. emarginatus* Nicholls, 1938.

First gnathopods: S, *O. microcarpus* K. H. Barnard, 1931; T, *O. zanzabaricus* K. H. Barnard 1937; U, type common to all other species.

Heads not drawn were never figured originally; these and their probable shapes are: *O. antennatus* K. H. Barnard, 1937, probably like fig. G; *O. microcarpus* K. H. Barnard, 1930, like fig. G but bearing eyes; *O. plumicornis* K. H. Barnard, 1925, possibly like fig. H; *O. proximus* Bonnier, 1896, like fig. J but rostrum more horizontal; *O. zanzabaricus* K. H. Barnard, 1937, like fig. G, but rostrum even more deflexed.

drawn backwards into an acute tooth; uropod 2 reaching nearly the full length of uropod 3; dorsal surface of body relatively smooth, not multicarinate; first two pairs of pereopods bear a seventh article; when present the eyes are contiguous but separated by a distinct midline, not completely fused; outer plate of maxilla 2 lacks a stout spine differentiated from the normal setae.

Type species: *O. rostratus* (Stebbing).

Remarks:

Shoemaker did not discuss the relationship of *Oediceropsoides* to other genera in the family. One might presume that he erected it on the basis of eye loss, but in other respects it does not differ from the type of *Oediceroides* and a number of eyeless species have been described. No doubt *Oediceropsoides abyssorum* has a peculiar head morphology but of no greater extreme than some other species now referred to the genus.

Few criteria, except for the quantitative measure of head shapes, are available for interspecific diagnoses in the genus. One species, *O. antennatus* has a long second peduncular article of the first antenna, peculiar only to that species; another, *O. microcarpus*, has a very small fifth article on the gnathopods (Fig. 56S) and is unique in this respect; a third species *O. zanzabaricus* has the lobe on the fifth articles of the gnathopods occupying only the distal half of the article, and is distinctive for that; otherwise, only heads are useful, except for the rounded or emarginate telsonic apices, varying from species to species.

The following key to *Oediceroides* is based, where possible, on the above criteria. Heads of the species are redrawn from the literature in Fig. 56, except for those species where no figure has appeared. Such species are noted and their probable head shapes described in the caption for Fig. 56.

Key to Oediceroides

Letter figures refer to Fig. 56

1. Antenna 1, article 2 longer than 1 . . . . *antennatus*[1]
1. Antenna 1, article 2 equal to or shorter than 1 2
2. Back studded with tubercles . . . . *ornatus*
2. Back relatively smooth, no tubercles, occasionally ridges are present 3
3. Article 6 of gnathopods 4 times as long as article 5 . . . . *microcarpus*

---

[1] A poorly known species.

3. Article 6 of gnathopods never more than twice as long as article 5 4
4. Rostrum gibbous (fig. F) 11
4. Rostrum not gibbous 5
5. Rostrum not tapering evenly to an acute point 6
5. Rostrum tapering evenly to an acute point 15
6. Rostrum evanescent, shorter than article 1 of antenna 1 . . . . *brevirostris*
6. Rostrum equal to or much longer than article 1 of antenna 1, tapering to a blunt attenuated end 7
7. Rostrum with grossly attenuated point . . . . *rostratus*
7. Rostrum blunt apically, but often minutely attenuated 8
8. Rostrum very slender but blunt apically . . . . *abyssorum*[1]
8. Rostrum stout but often minutely attenuated ventrally 9
9. Telson rounded apically 10
9. Telson emarginate . . . . *emarginatus*
10. Rostrum minutely beaked ventrally . . . . *apicalis*
10. Rostrum not beaked, blunt apically . . . . *ornithorhynchus*
11. Rostrum defleced nearly at right angles, very attenuated, acute and long . . . . *pirloti*
11. Rostrum not strongly deflexed, less than 30°, not attenuated, or short 12
12. Eyes bearing lateral cyst . . . . *cystifera*
12. Eyes lacking lateral cyst 13
13. Rostrum very gibbous (fig. F) . . . . *newnesi*
13. Rostrum scarcely gibbous 14
14. Head corner produced, subacute . . . . *macrodactylus*
14. Head corner blunt, scarcely produced . . . . *calmani*
15. Rostrum extending only halfway along antenna 1, article 1 16
15. Rostrum extending to end of or beyond end of antenna 1, article 1 17
16. Gnathopods 1-2, hind lobe of article 5 occupying $^{3}/_{4}$ of hind margin of article 6 . . . . *wolffi* n.sp.
16. Gnathopods 1-2, hind lobe of article 5 occupying only half of hind margin of article 6 *zanzabaricus*[2]
17. Rostrum strongly deflexed (fig. O) 18
17. Rostrum not strongly deflexed 19
18. Gnathopod 2, lobe of article 5 slender, geniculate . . . . *similis*
18. Gnathopod 2, lobe of article 5 broad, straight . . . . *weberi*
19. Eyes present . . . . *cinderella*
19. Eyes absent 20
20. Dorsal surface of pleon minutely tuberculate, downy . . . . *proximus*
20. Dorsal surface of pleon smooth 21
21. Antenna 1 strongly set with plumose setae, telson rounded . . . . *plumicornis*
21. Antenna 1 poorly setose, telson emarginate . . . . *limpieza* n.sp.

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[1] SHOEMAKER, 1925, as *Oediceropsoides*.

[2] A poorly known species.

cf. **Oediceroides apicalis** K.H.Barnard, 1931
(Fig. 57)

Oediceroides ornatus, CHILTON 1921: 66 (not STEBBING 1888).

Oediceroides apicalis K.H.Barnard, 1931: 121-122, fig. 2.

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Male, 20 mm; male, 12 mm. Total: 2 specimens.

Diagnosis:

Rostrum large, projecting cylindrically, reaching to end of article 2 on antenna 1, lower apex with small, sharp tooth; article 2 of peduncle on antenna 1 not longer than article 1; eyes covering rostrum but not pigmented; lateral lobe of head slightly produced and subacute; pereon segments slightly corrugated; telson entire, not emarginate; gnathopods normal.

Remarks:

The species is otherwise like *O.rostratus* (see

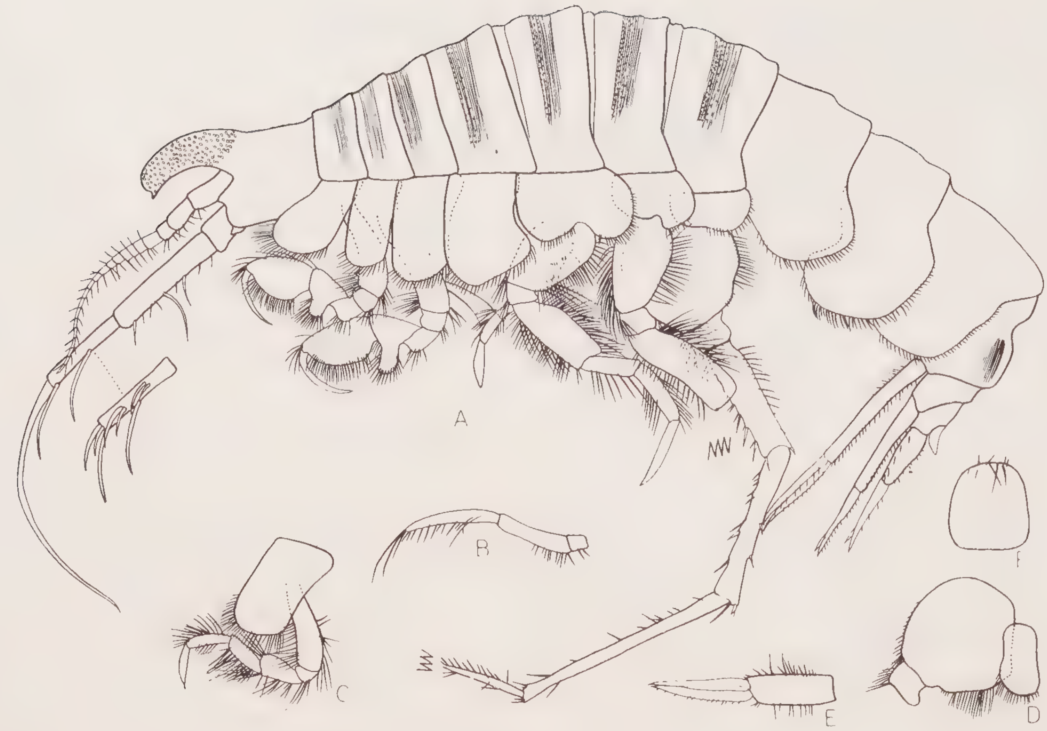


Fig. 57. *Oediceroides apicalis* K. H. Barnard. Male, 20 mm, St. 626. A, lateral view; B, palp of mandible; C, D, pereopods 1, 5; E, uropod 3; F, telson.

STEBBING 1888: pls. 60, 61) in mouthparts and other characters. *Oediceroides apicalis* differs from *O. rostratus* only by the smallness of the apical tooth on the rostrum, which in *O. rostratus* is a large attenuated piece and by the non-emarginate telson. K. H. BARNARD originally figured only the rostrum, so that the identification remains doubtful.

Distribution:

Coral Sea, northeast coast of Australia, 205 m; east slope of Bass Strait; Tasman Sea, west of New Zealand, 610 m.

Oediceroides limpieza n. sp.

(Fig. 58)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, female, 13 mm; figured female, 12 mm. Total: 2 specimens.

Diagnosis:

Rostrum relatively straight, tapering evenly to a subacute apex, reaching to end of article 1 on antenna 1; dorsum of rostrum with a minute keel, disappearing at its base; lateral lobe of head blunt; eyes absent; article 2 of antenna 1 slightly shorter than article 1; peduncle of antenna 2 lacking large stout spines; body not tuberculate, either grossly or minutely; first four pereon segments with slight dorsolateral depressions bounded by low ridges; gnathopods with fifth articles large and broadly lobate; telson strongly emarginate.

Relationship:

See the preceding key to *Oediceroides*. The species is closely related to *O. proximus* Bonnier, 1896 and *O. plumicornis* K. H. Barnard, 1925, but has an emarginate telson, a poorly setose first antenna and no minute pleonal tubercles. It is also related to *O. cinderella* Stebbing, 1888, but has an emarginate telson and lacks eyes. It differs from *O. weberi* Pirlot, 1932 by the much longer rostrum and emarginate telson.

Oediceroides macrodactylus alcaldia n. subsp.

(Fig. 59)

Oediceroides macrodactylus Schellenberg, 1931: 140-142, fig. 74.

Material:

St. 556, Great Australian Bight, 37°18′S 138°43′E, 795 m, clay, PGI 0.2, 6. XII. 1951. Holotype, male, 8 mm, unique.

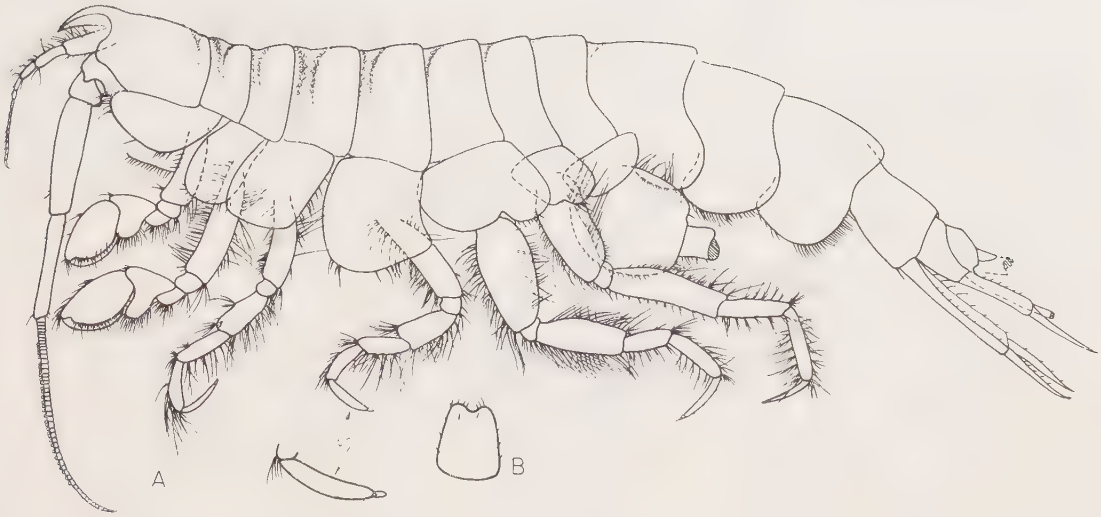


Fig. 58. *Oediceroides limpieza* n.sp. Female, 12 mm, St. 626. A, lateral view; B, telson.

Diagnosis:

Rostrum slightly gibbous, bearing a minutely attenuated point on the ventral apex; lateral head lobes slightly more blunt than in typical subspecies; eyes occupying most of rostrum; article 2 of peduncle on antenna 1 not longer than article 1; peduncle of antenna 2 not bearing large spines; article 5 of gnathopods not pointed as in the typical subspecies; article 7 of pereopods 3 and 4 with claw apically bubble-shaped; dorsal surfaces of pereon segments 1 to 7 with slight ridges and depressions; telson very slightly emarginate.

Mouthparts are like *O.cinderella* (Stebbing, 1888: pl. 62) except that article 3 of the mandibular palp is long, like *O.rostratus* (Stebbing, 1888: pl. 60).

Remarks:

The questions of identification in relation to other species lie in the gnathopods which are not as stout as in *O.cinderella* but more like those of *O.proxi-*

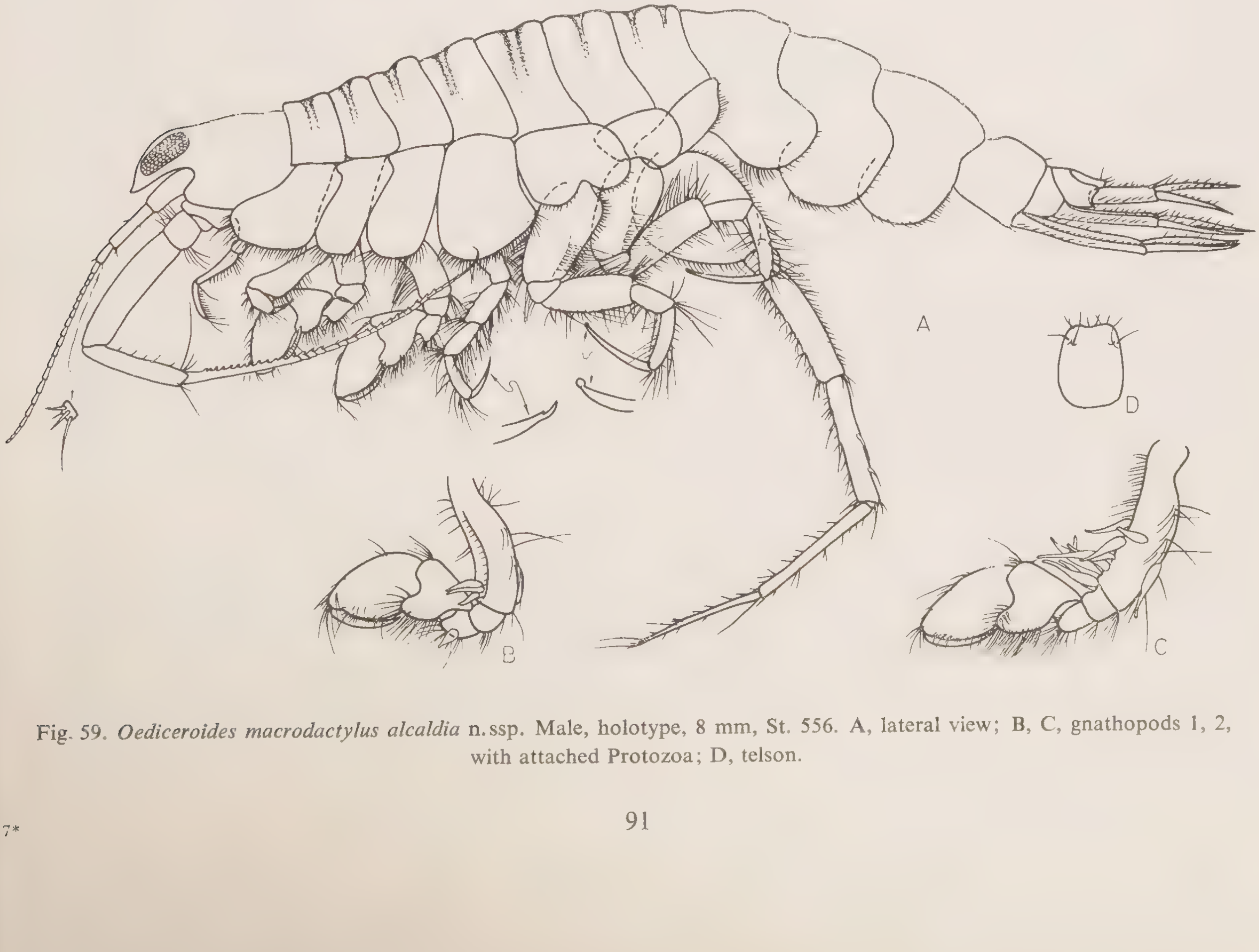


Fig. 59. *Oediceroides macrodactylus alcaldia* n.ssp. Male, holotype, 8 mm, St. 556. A, lateral view; B, C, gnathopods 1, 2, with attached Protozoa; D, telson.

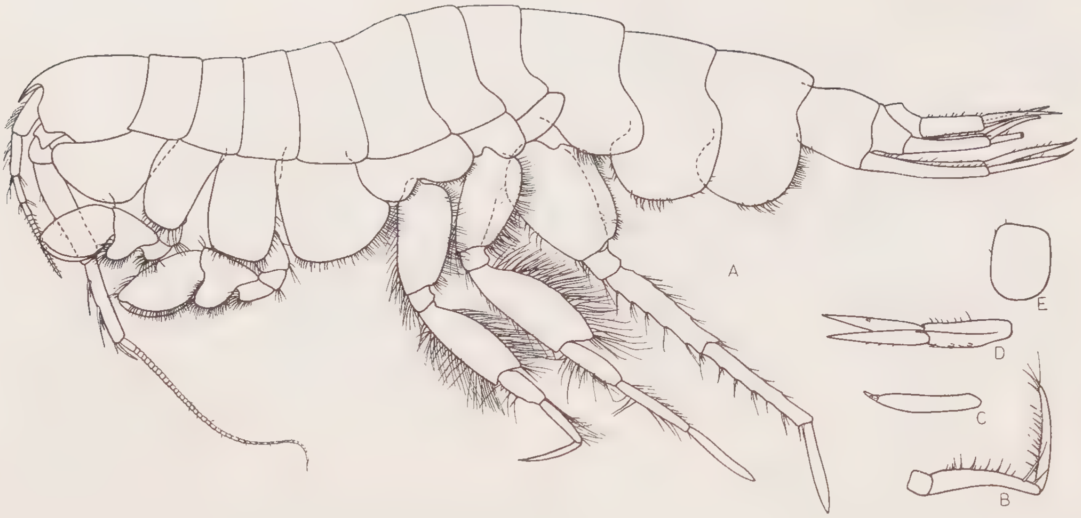


Fig. 60. *Oediceroides wolffi* n. sp. Male, holotype, 16 mm, St. 241. A, lateral view; B, palp of mandible; C, article 7 of pereopod 1; D, uropod 3; E, telson with distal edge at top.

mus, with the fifth articles asymmetrical and inclined distally. The rostrum seems stouter and longer than in STEBBING's small drawing of *O. cinderella;* the telson is slightly emarginate, and the first two pereopod pairs have the tip of article 7 clawlike and not bearing an apical bubble.

Oediceroides wolffi n. sp.

(Figs. 60, 61)

Material:

St. 241, off Kenya, 4°00′S 41°27′E, Globigerina ooze, 1510 m, HOT, 15. III. 1951. Figured male, holotype, 16 mm; two females, 21 and 18 mm; total specimens: 3.

St. 607, Tasman Sea, 44°18′S, 166°46′E, 3580 m, clay, HOT, 17. I. 1952. ?Sex, 6 mm.

Diagnosis:

Rostrum scarcely deflexed, nearly straight, small, acute, scarcely reaching half way along article 1 of antenna 1; lateral lobes of head square; article 2 of antenna 1 slightly shorter than article 1; body lacking tubercles; telson truncate; palp article 3 of mandible as long as article 2; gnathopods normal.

Relationship:

This species is very close to *O. weberi* Pirlot, 1932, but differs by the shorter, less deflexed rostrum. In *O. weberi* the rostrum would reach to the end of article 1 on antenna 1 if it were straightened, whereas the present species has the rostrum less than half as long as that article.

In other respects not described or figured the species is identical to *O. weberi.*

The new species is very closely related to *O. cinderella* Stebbing, 1888 (pl. 62); in fact the two species deserve close comparison. *O. wolffi* differs from *O. cinderella* in the long third palp article of the mandible, which in *O. cinderella* is only two thirds as long as article 2. The head is not as incised between the rostrum and lateral lobes in *O. wolffi* as in *O. cinderella.* In addition, the apices of the dactyls on the pereopods of *O. cinderella* are armed with minute, flat lobular claws which in *O. wolffi* are slender.

The small specimen from the Tasman Sea and the 3 large specimens cited below may represent a subspecies but because of the small size of the St. 607 specimen and the lack of small specimens from off Kenya, one cannot determine whether the slight differences are those of juvenility. The rostrum is very slightly shorter and less acute and the third pleonal epimeron is straighter behind. The St. 607 specimen is in poor condition, with most of its setae having been worn off, the last three pairs of pereopods broken and the uropods missing.

Doubtful material:

St. 601, Tasman Sea, 45°51′S 164°32′E, 4400 m, Globigerina ooze, HOT, 14. I. 1952. One head end belonging to a specimen probably 20 mm in length. It is like the *O. wolffi* of St. 607 above, having the shorter rostrum.

St. 663, Kermadec Trench, 36°31′S 178°38′W, 4410 m, brown sandy clay with pumice, HOT,

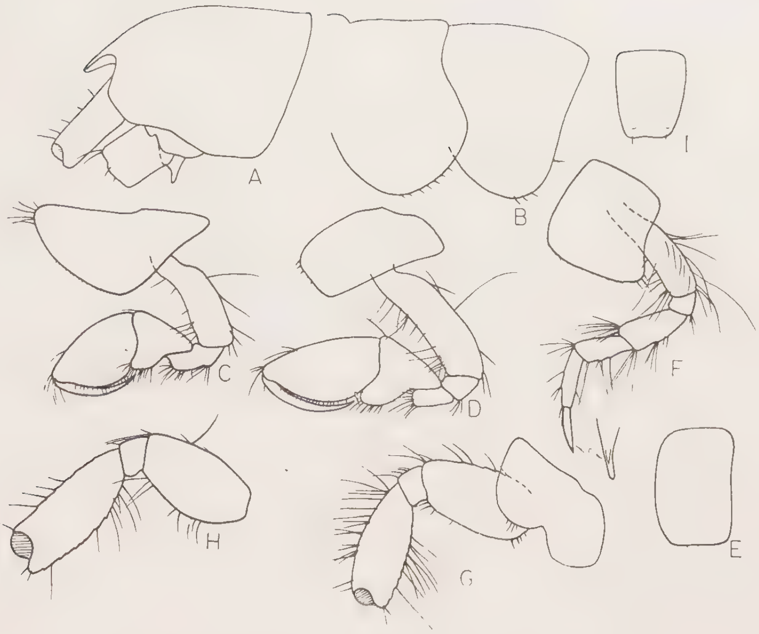


Fig. 61. *Oediceroides ?wolffi* n.sp. ?Sex, 6 mm, St. 607. A, head; B, pleon segments 2-3; C, D, gnathopods 1, 2; E, coxa 7 F, G, H, pereopods 2, 3, 4; I, telson.

24. II. 1952. Two head ends 10 and 14 mm long of specimens probably 20 mm long. They are like the *O. wolffi* of St. 607 above, having the shorter rostrum.

These large specimens indicate that the short rostrum is a characteristic feature of south Pacific adult *O. wolffi;* however, the lack of complete specimens prevents perfect identification with the small St. 607 specimen, for the telsonic configuration must be confirmed.

Lopiceros n. subgen.

Diagnosis:

Rostrum evanescent, not projecting farther than lateral lobes of head; antenna 2 with bulbous base to flagellum; palp article 3 of mandible subfalcate; inner plate of maxilla 1 very large, translucent, unarmed; maxilla 2 with very broad inner plate, outer plate lacking a stout spine, bearing only slender setae; gnathopods 1 and 2 similar in structure, subchelate, sixth articles longer than fifth, hind lobes of fifth poorly developed, palms merging with hind margins.

Type species: *Oediceroides (Lopiceros) forensia* n. sp.

Relationship:

The discovery of this new subgenus raises several problems in the genera *Oediceroides, Anoediceros* and *Oediceropsis*. The characters used to define *Lopiceros* are of the same unimportance as the distinguishing features among the three named genera. *Oediceropsis* differs from *Oediceroides* by the presence of lateral eyes, while many species of *Oediceroides* lack any eyes. *Anoediceros* differs from *Oediceroides* primarily by the possession of a stout spine on the outer plate of second maxilla. Indeed, these are characters of dubious value. In the genus *Oediceroides* the species *O. microcarpus,* with its strikingly unique gnathopods justifiably could be segregated as a subgenus; perhaps *O. zanzabaricus,* with its aberrant gnathopods could also be made the type of another subgenus. If these changes were made, then *Anoediceros* probably should be reduced to subgeneric status.

On first inspection the new subgenus, *Lopiceros,* appears to belong more to *Anoediceros* than to *Oediceroides,* because of the evanescent rostrum. However, *Lopiceros* lacks the minor distinction of bearing a stout spine on the outer plate of the second maxilla and the inner plate of that organ is broader than in *Anoediceros*. In addition, the second articles of pereopods 3 and 4 are broader and the shape of the third mandibular palp article differs from the linear one of *Anoediceros.*

Only one species of *Oediceroides, O. brevirostris* Schellenberg, 1931 has a rostrum approaching the reduction seen in *Lopiceros forensia* and by this intergradation it would be possible to include *L. forensia* in the typical *Oediceroides. O. brevirostris* bears well developed eyes and well developed hind lobes on the fifth articles of the gnathopods, however.

In the final analysis, if *Lopiceros forensia* were

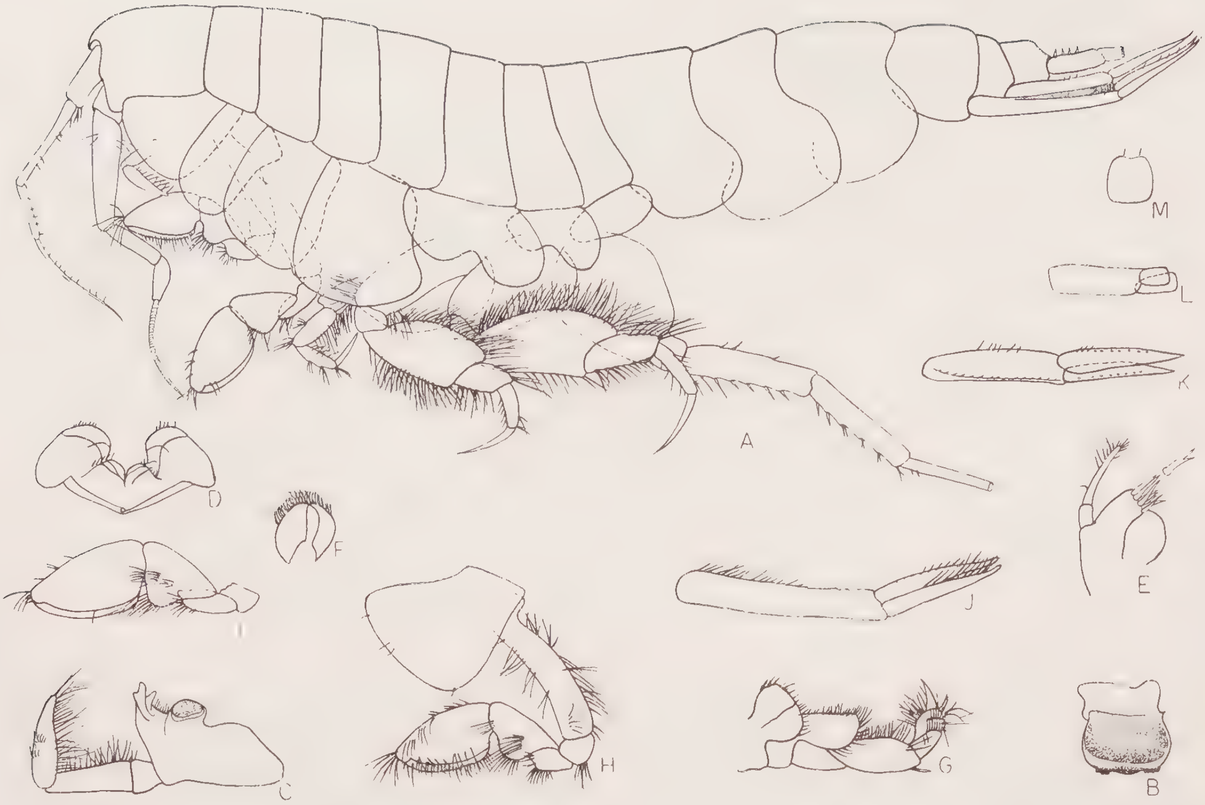


Fig. 62. *Oediceroides (Lopiceros) forensia* n. sp. Female, holotype, 16 mm, St. 607. A, lateral view; B, upper lip; C, mandible; D, lower lip; E, F, maxillae 1, 2; G, maxilliped; H, I, gnathopods 1, 2; J, K, L, uropods 1, 2, 3, the latter with broken rami; M, telson.

assigned directly to *Oediceroides,* its distinctive intergrading characters would be masked. They bear further study in terms of connecting relationships among the several genera concerned.

Unfortunately, only one specimen exists and the uniformity of the swelling on the basal antennal flagellum cannot be demonstrated, except that it exists bilaterally. This is the only qualitative feature by which *Lopiceros* can be distinguished. By assigning the subgenus to *Oediceroides,* rather than to *Anoediceros,* the importance of the spine character on the outer plate of the second maxilla in *Anoediceros* is retained, thus minimizing the quantitative intergradation of rostral evanescence which progresses from *Oediceroides* to both *Anoediceros* and *Lopiceros.* Otherwise, a key to genera might require the use of rostral evanescence, rather than features of qualitative value, minor as they are.

Oediceroides (Lopiceros) forensia n. sp.

(Fig. 62)

Material:

St. 607, Tasman Sea, 44°18'S 166°46'E, 3580 m, clay, HOT, 17. I. 1952. Holotype, female, 16 mm. Unique.

Diagnosis:

With the characters of the subgenus.

The inflated basal portion of the second antennal flagellum is the principal subgeneric character. Pereopods 3 and 4 have a lateral setose ridge on article 2, while article 4 folds into the slight pocket formed by this ridge. The epistome is rounded bulbously in front. Uropod 3 is broken.

Parhalimedon tropicalis n. sp.

(Fig. 63)

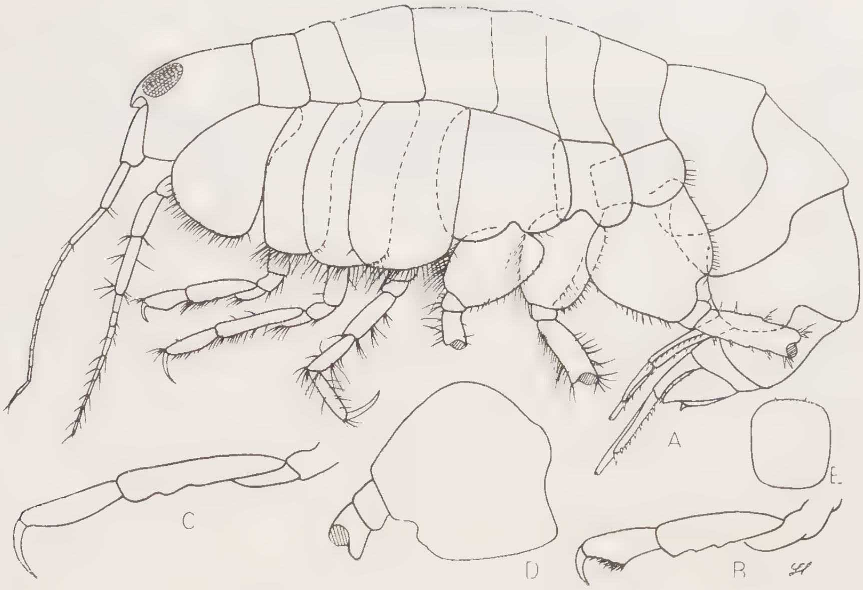
Material:

St. 548, Coral Sea, 30°00'S 154°34'E, 230 m, sand, PGI 0.2, 11. XI. 1951. Holotype, female, figured, 5 mm. Unique.

Diagnosis:

Head with short rostrum, eyes moderately large, occupying upper and forward surface of head just back of rostrum, well developed structurally and separated distinctly by a space on the dorsal surface which is about 1/6 of the eye width; lateral lobes of head with straight anterior edges and quadrate corners; first antenna as long as second; lower

Fig. 63. *Parhalimedon tropicalis* n.sp. Female, holotype, 5 mm, St. 548. A, lateral view; B, C, gnathopods 1, 2; D, pereopod 5; E, telson.



corner of third pleonal epimeron rounded, lacking a tooth; telson nearly square.

Relationship:

This species has only minor differences from its Antarctic relative, *P. turqueti* Chevreux, 1906 (p. 34), the type and only other species of the genus. These differences are detailed in the diagnosis, the larger, better developed eyes crowded near the rostrum, the long first antenna, the lack of a third pleonal epimeron tooth, and the telson with straight posterior border.

The genus *Parhalimedon* is distinctive also for the shortened outer rami of the first and second uropods, besides the features of the CHEVREUX' (1906) diagnosis. The mouthparts of the new species correspond exactly with those figured and described by CHEVREUX, including the large and setose inner plate of the maxilliped. The discovery of a second species of *Parhalimedon* reinforces the importance of the narrowed distal part of the second article on the fifth pereopod, a feature useful generically. Chevreux noted the resemblance of *Parhalimedon* to *Westwoodilla* and *Bathymedon,* distinguishing it from those by the inner plate of the first maxilla, but an additional feature of equal importance, used by me in the generic key to the family, is the difference in mandibular primary cutting edges, which in *Parhalimedon* are projecting and toothed, in contrast to other genera mentioned.

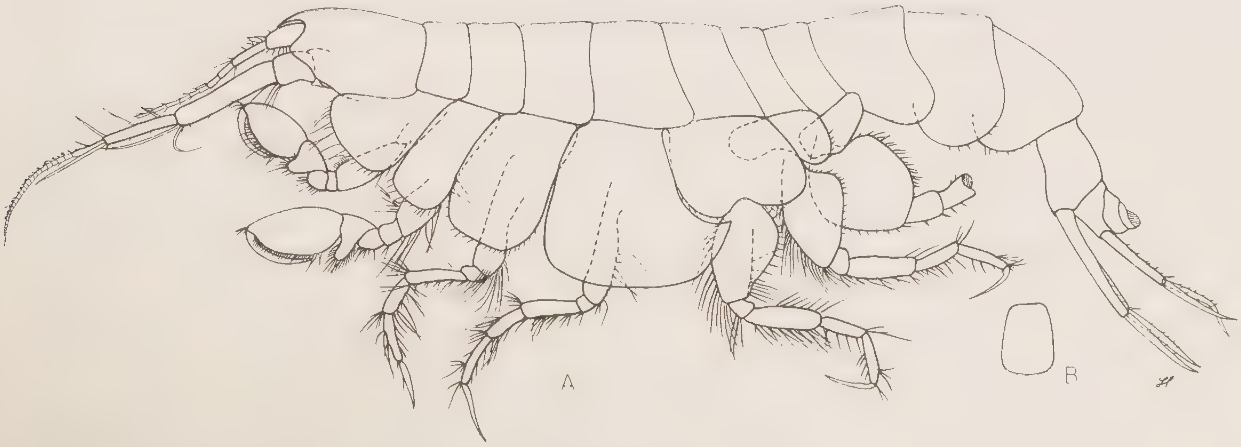


Fig. 64. *Paroediceroides trepadora* n.sp. Female, holotype, 5 mm, St. 729. A, lateral view, uropod 3 missing; B, telson, distal towards top.

Paroediceroides trepadora n. sp.
(Fig. 64)

Material:

St. 729, Gulf of Panama, 7°22′N 79°33′W, 875 m, green clay, PGI 0.2, 14. V. 1952. Holotype, female, 5 mm. Unique.

Diagnosis:

Head with slender acute rostrum reaching two thirds along article 1 of antenna 1; lateral lobes of head not projecting as far forward as rostrum, subacute; eyes absent; pereopods 1 and 2 with very slender articles; telson truncated.

Mouthparts similar to *Oediceropsis brevicornis* Liljeborg (see Sars 1895: pl. 114).

Relationship:

Prior to this, the genus *Paroediceroides* was monotypic, with *P. plumosa* Schellenberg, 1931, the type species. It may be questionable not to erect a new genus for the present species since the telson is truncated, not deeply emarginate, but other oedicerotid genera show variation nearly to the same extremes (such as *Monoculodes)*. The distinctive feature of the genus is the acutely produced posterior lobe of coxa 4; otherwise the genus might be placed in *Oediceroides*. Nevertheless, it is convenient and perhaps natural to separate *Paroediceroides* from *Oediceroides* despite my belief that the two species now belonging to it probably had different origins, in view of the different heads, telsons and first two pereopods.

Parasite (fig. 65):

The brood pouch of this female contained one large egglike isopod parasite, which distended the coxae and legs. The 0.9 mm organism was sketched superficially. Isopod parasites of amphipods are probably common and little studied. The writer has seen them on a number of occasions, usually at the expense of eggs, for by their large size they occupy nearly the whole brood pouch. Whether the presence of the parasite delays molting of the host or whether it crowds out broods of young are questions of interest to be studied.

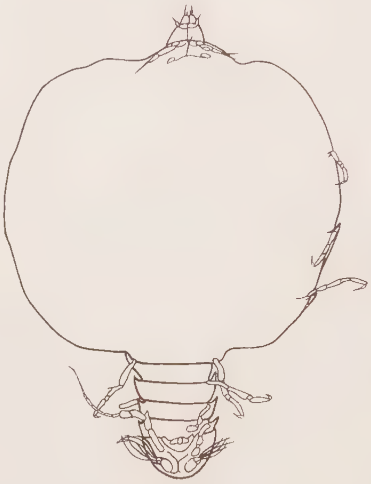


Fig. 65. Parasitic isopod enclosed in brood pouch of *Paroediceroides trepadora* n. sp. 0.9 mm long, ventral view.

FAMILY EUSIRIDAE

Genus **Eusirus** Krøyer

Key to Eusirus Females

1. Pleon segment 3 with a dorsal tooth	2
1. Pleon segment 3 lacking a dorsal tooth	7
2. Urosome segment 1 with a dorsal tooth	3
2. Urosome segment 1 lacking a dorsal tooth	4
3. Process on article 5 of gnathopods conical and slender	*bathybius*
3. Process on article 5 of gnathopods blunt and broad	*abyssi*
4. Pereon segments 5-7 with dorsal teeth	*perdentatus*
4. Pereon segments 5-7 lacking dorsal teeth	5
5. Third pleonal epimeron serrate only on distal half	*parvus*
5. Third pleonal epimeron serrate its full length	6
6. Telson cleft one-third its length	*leptocarpus*
6. Telson minutely cleft, less than $^{1}/_{20}$th its length	*biscayensis*
7. Posterior edge of third pleonal epimeron not serrate	8
7. Posterior edge of third pleonal epimeron serrate	10
8. Pleon lacking dorsal teeth, processes on fifth articles of gnathopods blunt, stout	*laevis*
8. Pleon bearing dorsal teeth, processes on fifth articles of gnathopods slender, conical	9

9. Pereon segment 7 with small tooth, pleon segments 1-2 with small teeth......... *nevandis* n.sp.
9. Pleon segments 1-2 with large teeth.. *fragilis*[1]
10. Telson cleft a third of its length or more...................................... 11
10. Telson cleft less than one fifth of its length, often minutely and its lobes gape.............. 15
11. The conical lobe of article 2 on pereopod 5 reaching well below the end of article 3... *sp.* Pirlot
11. The lobe of article 2 on pereopod 5 rounded or not reaching beyond end of article 3........ 12
12. Article 4 of pereopods 1-2 twice as long as article 5.................................. 13
12. Article 4 of pereopods 1-2 1.5 times as long as article 5.............................. 14
13. Antenna 1, articles 1 and 2 equal in length.................................. *antarcticus*
13. Antenna 1, article 2 two thirds as long as 1.................................. *propinquus*
14. Pereon segment 7 bearing dorsal tooth....................................... *cuspidatus*
14. Pereon segment 7 lacking dorsal tooth... *longipes*
15. Anterior edges of articles 5-6 on gnathopod 1 equal in length......................... *microps*
15. Anterior edge of article 5 of gnathopod 1 almost twice as long as article 6................. 16
16. Pereon segment 7 lacking dorsal tooth.. *tjalfiensis*
16. Pereon segment 7 bearing dorsal tooth.. 17
17. Article 2 of antenna 1 half as long as 1... *minutus*
17. Article 2 of antenna 1 as long as 1... *holmi*

Eusirus nevandis n. sp.
(Fig. 66)

Material:

St. 241, off Kenya, 4°00′S 41°27′E, Globigerina ooze, 1510 m, HOT, 15. III. 1951. Holotype, female?, 8 mm. Unique. The single specimen is badly damaged, lacking most articles of the antennae, pereopods and uropods.

Diagnosis:

Rostrum less than half as long as article 1 of antenna 1; eyes formed of indistinct cellular mass; gnathopods with upper edge of article 5 nearly twice as long as upper edge of article 6; hind lobes of fifth articles slender, conical; pereon segment 7 and pleon segments 1-2 with a minute dorsal tooth, pleon segments 3 and 4 lack dorsal teeth but bear slight keels; posterior edge of third pleonal epimeron with smooth, neither crenulate nor toothed edge; telson short, very broad, cleft less than a fifth of its length, the acute lobes gaping; article 5 of pereopods 1-2 nearly as long as article 4.

Relationship:

This species differs from *E. laevis* Walker, 1903 by the blunt processes on articles 5 of both gnathopods. Only the new species, *E. laevis* and *E. fragilis* Birstein and Vinogradov, 1960 in the genus have smooth third epimeral margins. The new species is so close to *E. fragilis* (of the Tonga Trench) as to defy separation; in their description BIRSTEIN and VINOGRADOV say that the teeth of pleon segments 1-2

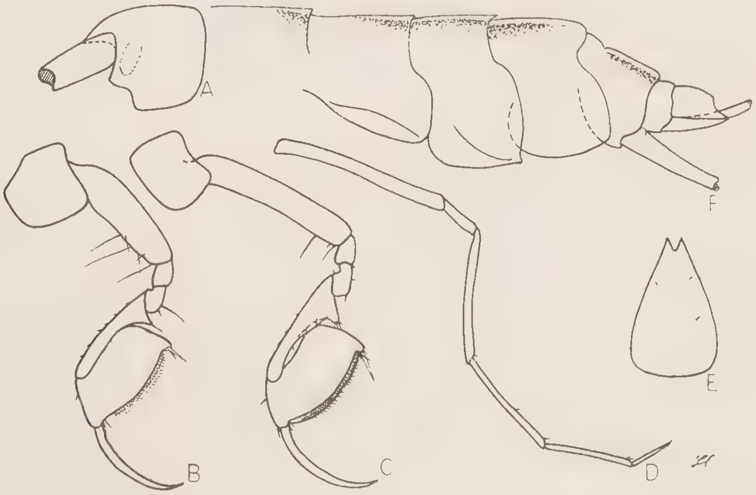


Fig. 66. *Eusirus nevandis* n.sp. ?Female, holotype, 8 mm, St. 241. A, head; B, C, gnathopods 1, 2; D, pereopod 2; E, telson; F, pleon.

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[1] BIRSTEIN and VINOGRADOV, 1960.

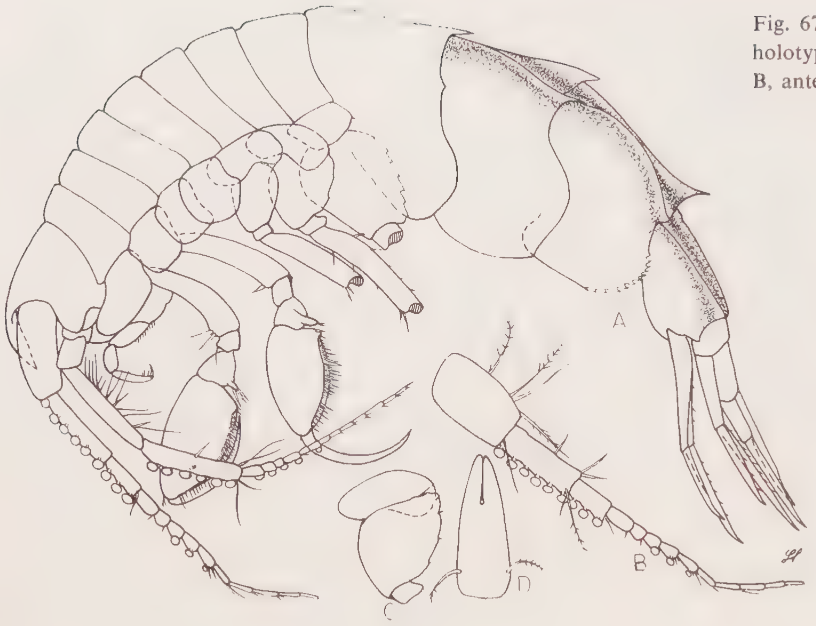

Fig. 67. *Rhachotropis levantis* n. sp. Female, holotype, 8 mm, St. 626. A, lateral view; B, antenna 1; C, pereopod 4; D, telson.

are large, whereas they are small in the new species and a tooth is present on pereon segment 7 in the new species, another possible difference. The wide geographic separation between Kenya and Tonga may be insignificant as eusirids are pelagic. The fragility of both the new species and *E.fragilis* contribute to the confusion and also indicate their close relationship as well as the fact that other imperfect specimens may be stored in museums. Until more comparisons can be made the writer believes in retaining the Tonga and Kenya collections as separate entities.

Rhachotropis levantis n. sp.

(Fig. 67)

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, HOT, 20. I. 1952. Holotype, female, 8 mm, figured; and 2 additional broken specimens. Total specimens: 3.

Diagnosis:

Rostrum deflexed, reaching two-thirds along article 1 of antenna 1; lateral lobes of head narrow and blunt; pereon lacks dorsal ridges or teeth; pleon segment 1 with an acute middorsal tooth and a small lateral one on each side, but lacking a lateral ridge; pleon segment 2 with a middorsal tooth, a long, acute lateral one springing from a lateral ridge; pleon segment 3 with a middorsal erect tooth, and a lateral ridge which ends bluntly; pleon segments 4-6 not ornamented middorsally, but segment 4 bearing an oblique lateral ridge; third pleonal epimeron with lower posterior edge rounded and toothed; pereopod 4, article 2 alate, telson cleft one-third its length; outer rami of uropods 1 and 2 much shorter than inner rami; rami of uropod 3 subequal in length.

Relationship:

A key to the genus *Rhachotropis* was written by J. L. Barnard, 1957. The present species keys out to couplet 20 where it is related to *R.grimaldii* (Chevreux). The new species differs in numerous ways from *R.grimaldii,* in the lack of large lateral teeth on pleon segments 1 and 3, the lack of a middorsal crest on pleon segment 4, in the broad, aliform second article of pereopod 4 and the apparently longer rostrum. *Rhachotropis flemmingi* Dahl, 1959, not in Barnard's key, is related to *R.hunteri* Nicholls, 1938 and *R.cervus* Barnard, 1957.

FAMILY LEPECHINELLIDAE

Lepechinella Stebbing, 1908

The following key shows the difficulty in defining precisely the three species in couplets 10 and 11, particularly in the separation of *L.sucia* n. sp. and *L.bierii* from *L.drygalskii.* Only by quantitative measures can this separation be made. Schellenberg (1926a) has not figured the pleon where the specific distinctions are likely to occur. See Dahl (1959) for a discussion of the genus.

Key to Lepechinella

The following key shows the difficulty in defining precisely the three species in couplets 10 and 11, particularly in the separation of *L. sucia* n. sp. and *L. bierii* from *L. drygalskii*. Only by quantitative measures can this separation be made. SCHELLENBERG (1926a) has not figured the pleon where the specific distinctions are likely to occur. See DAHL (1959) for a discussion of the genus.

1\. Coxa 1 bifid 2
1\. Coxa 1 not bifid 3
2\. Pleon segments 1-3 each with 2 teeth .... *arctica*
2\. Pleon segments 1-3 each with 3 teeth .... *chrysotheras*
3\. Pereon segments lack dorsal teeth .... *cetrata*
3\. Pereon segments bear dorsal teeth 4
4\. Dorsal teeth of pereon vestigial 5
4\. Dorsal teeth of pereon large, acute 6
5\. Coxa 5 with long anterior lobe .... *pangola*[1]
5\. Coxa 5 with short anterior lobe .... *ultraabyssalis*[1]
6\. Pereon segment 1 bearing 1 dorsal tooth .... *monocuspidata* n. sp.
6\. Pereon segment 1 bearing 2 dorsal teeth 7
7\. Pereon with articulated spines 8
7\. Pereon lacking articulated spines 9
8\. Pleon segments 5-6 fused .... *echinata*
8\. Pleon segments 5 and 6 separated .... *wolffi*[1]
9\. Dorsal pleonal teeth immensely larger than pereonal .... *curvispinosa*
9\. Dorsal pleonal teeth not larger than pereonal 10
10\. Dorsal pereonal teeth thick, short .... *drygalskii*
10\. Dorsal pereonal teeth slender, long 11
11\. Dorsal tooth of pleon segment 4 oblique .... *sucia* n. sp.
11\. Dorsal tooth of pleon segment 4 vertical .... *bierii*

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[1] *L. pangola* J. L. Barnard 1961; *L. ultraabyssalis* Birstein and Vinogradova, 1960; *L. wolffi* Dahl, 1959. Other references in J. L. BARNARD (1958).

Lepechinella monocuspidata n. sp.
(Fig. 68)

Material:

St. 241, off Kenya, 4°00'S 41°27'E, 1510 m, pure Globigerina, HOT, 15. III. 1951. Holotype, sex?, 8 mm. Unique.

Diagnosis:

Coxa 1 not bifid, relatively short; processes of head long; pereon segment 1 with only one erect tooth, each remaining pereon segment and pleon segments 1-4 with a dorsal tooth; the teeth are erect on pereon segments 2-4 and oblique on pereon segments 5-7 and pleon 1-4; pleon segments 5-6 fused, bearing a posterior tooth.

The accessory flagellum is uniarticulate and the mouthparts are like *L. chrysotheras* Stebbing, 1908. The mandibular palps are broken and missing.

Relationship:

The single tooth of pereon segment 1 is distinctive, all other known species having two teeth or none. BARNARD (1957) erred in his key to *Lepechinella*, assigning one dorsal tooth on pereon segment 1 for *L. drygalskii*, whereas two are present. The differences of *L. drygalskii*, *L. bierii* and *L. sucia* n. sp. are minor and are discussed under the latter heading.

Lepechinella sucia n. sp.
(Fig. 69)

Material:

St. 607, Tasman Sea, 44°18'S, 166°46'E, 3580 m, clay, HOT, 17. I. 1952. Holotype, male, 11 mm. Unique.

Diagnosis:

Coxa 1 not bifid, relatively short; head with medial, nearly horizontal rostral process, lower lateral process of head smaller than upper lateral process; pereon segment 1 with 2 dorsal processes, remaining segmental processes increasing slightly in size and

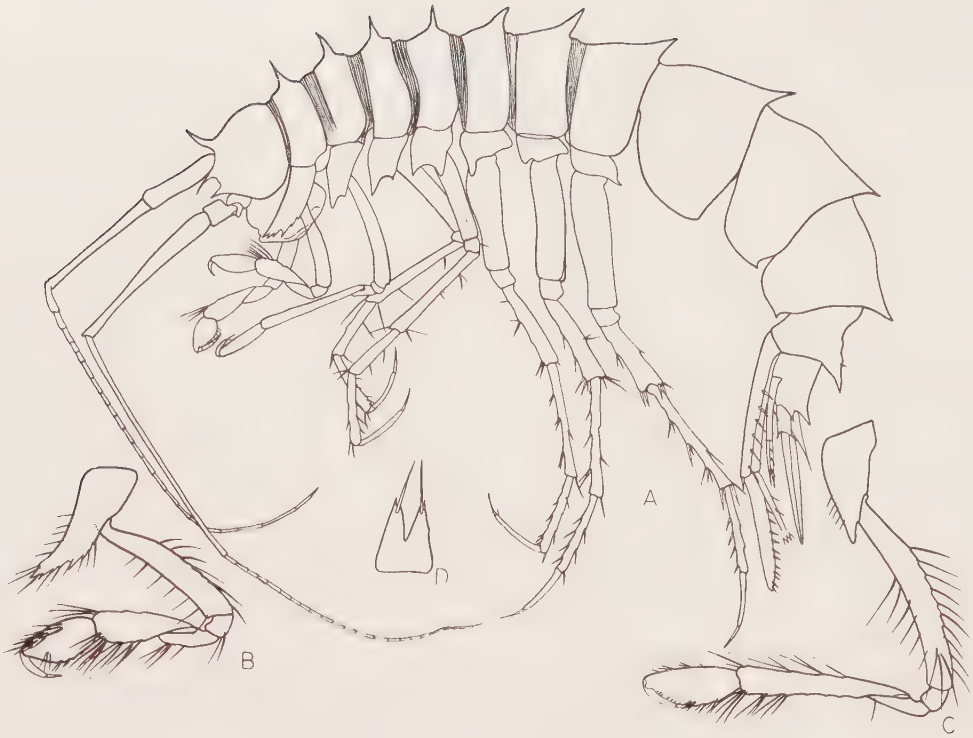

Fig. 68. *Lepechinella monocuspidata* n.sp. ?Sex, holotype, 8 mm, St. 241. A, lateral view; B, C, gnathopods 1, 2; D, telson.

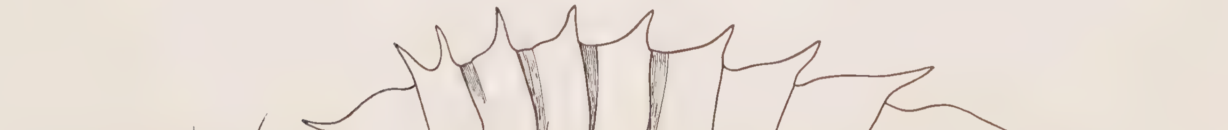

Fig. 69. *Lepechinella sucia* n.sp. Male, holotype, 11 mm, St. 607. A, lateral view; B, telson.

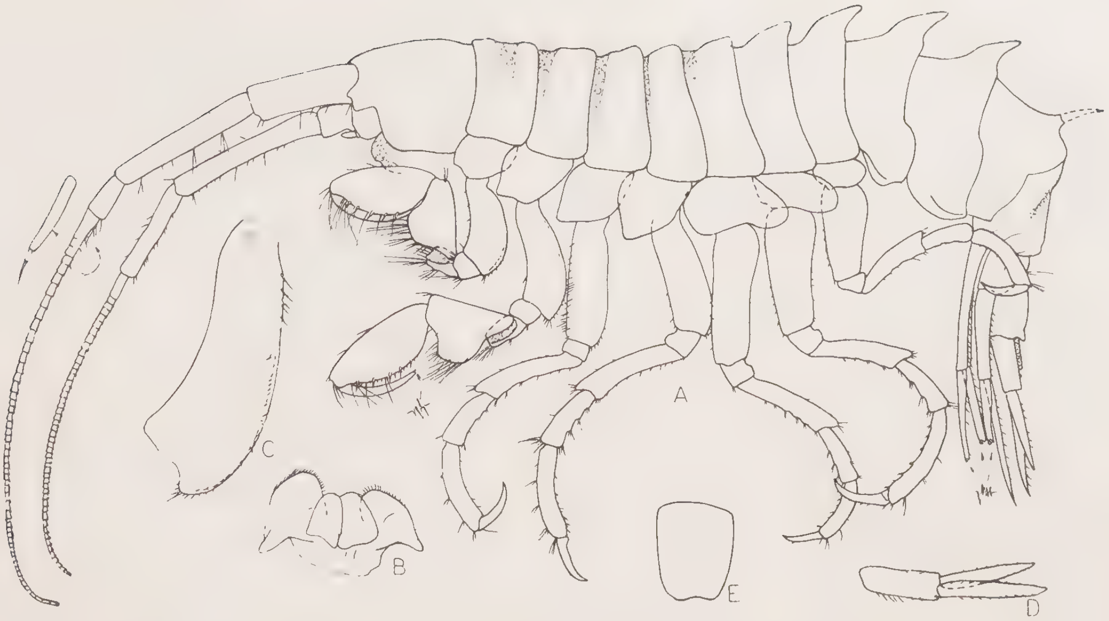

Fig. 70. *Amathillopsis grevei* n.sp. Male, holotype, 13 mm, St. 607. A, lateral view; B, lower lip; C, article 2 of gnathopod 2, right side; D, uropod 3; E, telson.

becoming oblique on pleon; pleon segments 5-6 nearly fused and bearing a moderately large tooth.

Mouthparts similar to *L. chrysotheras,* with the exceptions noted for *L. bierii* Barnard, 1957. Pereopod 5 and uropod 3 incomplete.

Relationship:

This species is very closely related to its eastern Pacific counterpart, *L. bierii* Barnard, 1957 from which it differs essentially only by the process of segment 6 being well developed and some minor points as follows: slightly larger dorsal processes of pleon; less sharply produced forward coxal margins; less sharply attenuated and upturned lower posterior corners of pleonal epimera; the shorter palms of the gnathopods; and the shorter apical claws of the pereopods.

The new species is related to *L. drygalskii* Schellenberg, 1926a (p. 345, fig. 50) from the Antarctic, but differs by the more slender dorsal processes of the pereon segments, the shorter palm of gnathopod 1 and probably the process of pleon segment 6, not mentioned by Schellenberg.

These three species, *L. sucia, L. bierii* and *L. drygalskii* seem to form the extremes in a Rassenkreis and may permit designation only as subspecies.

FAMILY AMATHILLOPSIDAE

Amathillopsis grevei n. sp.

(Fig. 70)

Material:

St. 607, Tasman Sea, 44°18'S 166°46'E, 3580 m, clay, HOT, 17. I. 1952. Holotype, male, 13 mm. Unique. Field color notes: head and body light green, mouthparts pink, the two anterior pairs of legs very pale bluish red.

Diagnosis:

Eyes absent; dorsal teeth reaching maximum length on pereon segment 7, pleon segments 1 and 2 and possibly 3 (broken); dorsal teeth commencing as rudiments on pereon segment 3 and increasing progressively in size through pereon segment 6; anterior corners of first 4 coxae angular but not very sharp and not attenuated, coxae relatively short and quadrate; hind lobes on sixth articles of gnathopods blunt, not attenuated; hind margin of article 2 on gnathopod 2 slightly but not grossly lobate and bearing small marginal spines; this condition slightly developed on gnathopod 1; teeth on lower corners of second and third pleonal epimera scarcely evident; posterior end of pleon segment 6 with a small medial tooth; telson broad, short, apically emarginate.

Accessory flagellum composed of a single slender article tipped with 2-3 spines.

Relationship:

This species bears a remarkable resemblance to *Amathillopsis (= Acanthopleustes) annectens* (Holmes, 1908) of California, and is distinct from it only by the broad, emarginate telson. The first four coxae of *A. annectens* are more sharply pointed than in the new species but the dorsal teeth and gnathopods are identical.

Amathillopsis grevei differs from *A. australis* Stebbing, 1888 (from the Coral Sea) by the blunter fifth article of gnathopod 2 and the shorter, quadrate, not acutely pointed, third and fourth coxae; the telsons of the two species are identical.

The new species differs from *A. atlantica* Chevreux, 1908a (from the Azores) by the shorter dorsal teeth, especially of pereon segment 6, the scarcely produced hind distal margin of article 2 on gnathopod 1 and the less attenuated anterior corner of coxa 2.

From *A. pacifica* Gurjanova, 1955 (from the Okhotsk Sea) the new species differs by the relatively poorly produced hind lobes on the second articles of the gnathopods and the short tooth of pereon segment 6, which in *A. pacifica* is as long as that on the seventh pereonal segment.

A. spinigera Heller (see Stebbing 1906) has dorsal teeth commencing on pereon segment 1 and *A. affinis* Miers (see Stebbing 1906) lacks any hind lobes on article 5 of the gnathopods.

FAMILY PARAMPHITHOIDAE

Diagnosis:

Mouthparts not developed for piercing and sucking nor drawn downward in a bundle; first three coxae pointed and attenuated; antenna 1 lacks more than a vestigial accessory flagellum; mandible with 3 palp articles and molar; maxillipeds with plates and palp of normal development; eyes lateral, when present; coxa 4 excavate behind.

Remarks:

In all genera the first 3 coxae are quite pointed and attenuated, except for the genus *Oradarea* Walker, transferred from the Calliopiidae to the Paramphithoidae by Pirlot (1934), and *Parepimeriella* Schellenberg, 1931. On the basis of Stebbing's (1906) key to the Gammaridea, *Oradarea* might better be put in the Pleustidae, except that the lower lip of pleustids is characteristic (see Barnard and Given 1960). The writer does not believe that the Paramphithoidae should be emended to accept *Oradarea* and that the Calliopiidae remains a logical place for it. The genus *Parepimeriella* has the characteristic lower lip and probably should be transferred to the Pleustidae.

Key to Paramphithoidae

1.	Body dorsally covered with articulated spines	*Uschakoviella*
1.	Body lacking articulated spines	2
2.	Molar of mandible only a setose lamina	3
2.	Molar of mandible well developed, large, ridged	4
3.	Pereopod 5 as long or longer than pereopod 4	*Eclysis*
3.	Pereopod 5 shorter than pereopod 4	*Epimeriella*
4.	Maxillipedal palp bearing only 3 articles	5
4.	Maxillipedal palp bearing 4 articles	6
5.	Lower lip with inner lobes	*Parepimeria*
5.	Lower lip lacking inner lobes	*Metepimeria*
6.	Coxae 4-5 together forming a crescentic curve below	*Epimeria*
6.	Coxae 4-5 together not forming a crescentic curve below	7
7.	Article 5 of gnathopods shorter than article 6	*Paramphithoe*
7.	Article 5 of gnathopods much longer than article 6	*Actinacanthus*

Epimeria Costa, 1851

Three species of *Epimeria* have a broad ventral edge on coxa 4, whereas the remaining species of the genus have the lower edge pointed. As a result, the crescentic curve formed with coxa 5 is less pronounced in the three species, *E. inermis, E. monodon* and *E. robusta.*

Key to Epimeria

1.	Pereon segments lacking dorsal carinae	2
1.	Some or all pereon segments bearing dorsal carinae	9
2.	Coxa 5 strongly and acutely produced posteriorly	3
2.	Coxa 5 not produced posteriorly	5
3.	Pleon segment 1 lacking tooth, coxa 4 relatively short	*longispinosa*
3.	Pleon segment 1 bearing small tooth, coxa 4 attenuated	4
4.	Rostrum long, eyes present	*pacifica*
4.	Rostrum short, eyes absent	*glaucosa* n. sp.
5.	Article 2 of pereopod 3 with posterior jagged notch	*robusta*
5.	Article 2 of pereopod 3 smooth posteriorly	6
6.	Dorsal carina starting on pleon segment 1	*puncticulata*
6.	Dorsal carina borne only or starting on pleon segment 3	7
7.	Coxa 4 broadly rounded below	*monodon*
7.	Coxa 4 acutely pointed below	8
8.	Rostrum reaching end of article 2 on antenna 1	*semiarmata*
8.	Rostrum not reaching end of article 1 on antenna 1	*pelagica*[1]
9.	Third pleonal epimeron bearing accessory tooth above lower corner	10
9.	Third pleonal epimeron lacking accessory tooth above lower corner	14
10.	Coxa 5 projecting acutely	11
10.	Coxa 5 not projecting acutely	12
11.	Dorsal carina starting on pereon segment 4	*victoria*[2]
11.	Dorsal carina starting on pereon segment 6	*cornigera*
11.	Dorsal carina starting on pereon segment 1	*loricata*
12.	Article 2 of pereopod 3 with posterior jagged notch	*excisipes*
12.	Article 2 of pereopod 3 smooth posteriorly	13
13.	Coxa 4 broadly rounded below	*inermis*
13.	Coxa 4 acutely pointed below	*tuberculata*
14.	Article 2 of pereopod 3 with posterior jagged notch	*georgiana*
14.	Article 2 of pereopod 3 smooth posteriorly	15
15.	Coxa 5 acutely produced	16
15.	Coxa 5 not acutely produced	17
16.	Pereon segments 3 to 7 with long, sharp dorsal teeth	*macrodonta*
16.	Pereon segments 3 to 7 with low carinae	*parasitica*
17.	Pereopods 4 and 5 with posterior edge of article 2 lobate	*intermedia*
17.	Pereopods 4 and 5 with posterior edge of article 2 not lobate	*bruuni* n. sp.

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[1] Birstein and Vinogradov, 1958.

[2] Hurley, 1957.

Epimeria bruuni n. sp.

(Fig. 71)

Material:

St. 665, Kermadec Trench, 36°38'S 178°21'E, 2470 m, grey clay, HOT, 25. II. 1952. Holotype, male, 7 mm. Unique.

Diagnosis:

Dorsal carinae borne on pereon segments 6-7 and pleon segments 1-3, terminating in blunt teeth, except on pereon segment 6 and poorly on pleon segment 3; pleon segment 4 with a blunt, erect carina; pleon segment 6 with a dorsal bump; coxa 4 strongly attenuated and geniculate, apex blunt but narrow; coxa 5 not produced strongly, lower posterior corner angular; posterior edges of second articles on pereopods 3-5 lacking notches; third pleonal epimeron lacking tooth at lower posterior corner or accessory tooth; eye-bulges on head lacking pigment or ommatidea; rostrum large; outer ramus of uropod 2 shortened.

Relationship:

This species is unique in the genus for its third pleonal epimeron which has the posterior edge bowed and the lower corner rounded.

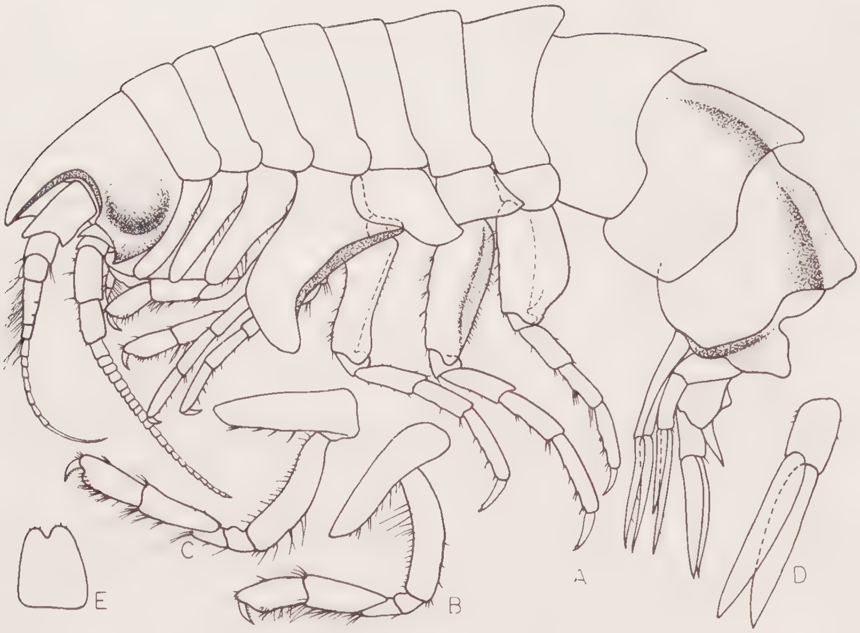

Fig. 71. *Epimeria bruuni* n. sp. Male, holotype, 7 mm, St. 665. A, lateral view; B, C, gnathopods 1, 2; D, uropod 3; E, telson.

Epimeria glaucosa n. sp.

(Fig. 72)

Material:

St. 575, Tasman Sea, 40°11′S 163°35′E, 3710 m, pteropod ooze, SOT, 19. XII. 1951. Holotype, female, 22 mm, with hatched juveniles; figured ovigerous female, 19 mm. Total: 2 specimens.

Diagnosis:

Eyes absent, rostrum of medium size, extending to end of first antennal article 1; coxa 4 recurved, attenuated, acute below; coxa 5 acutely produced at lower posterior corner; pereon segments lack carinae; pleon segments 1-4 bear acute dorsal carinae and teeth, pleon segment 4 with a shallow notch anterior to the carina; telson scarcely emarginate; third pleonal epimeron with sharp, slightly produced lower corner and a slight, obtuse process midway on the posterior margin; pereopods 3 and 4 with straight posterior edges on second articles; article 2 of pereopod 5 narrowing distally but not abruptly.

Relationship:

This species is related to *E.pacifica* Gurjanova, 1955 (p. 191-194, figs. 12, 13) but differs by the shorter rostrum, lack of eyes, shorter process of coxa 5, the less abruptly narrowing second article of pereopod 5, and the posteromedial marginal process of the third pleonal epimeron.

The hatched juveniles of the holotype differ from the adults in the poorly developed process of the third pleonal epimeron; otherwise they are identical.

FAMILY CALLIOPIIDAE

Metaleptamphopus Chevreux, 1911

Metaleptamphopus Chevreux, in Chevreux 1912: 144.

Diagnosis:

Body lacking dorsal teeth; antenna 1 longer than antenna 2, lacking accessory flagellum; upper lip rounded below, not incised; lower lip lacking inner lobes; inner plate of maxilla 1 setose along inner edge; outer plates of maxilliped larger than inner plates; gnathopods subchelate, article 5 slightly shorter than article 6, articles of gnathopods not greatly elongated; telson apically rounded, smooth; outer ramus of uropod 3 hardly shorter than inner ramus.

Type species: *Metaleptamphopus pectinatus* Chevreux.

Relationship:

This genus differs from *Amphithopsis* Boeck only by the longer outer ramus of uropod 3, the lack of an accessory flagellum and the shortness of article 5 on the gnathopods.

It differs from *Leptamphopus* Sars by the stouter, less linear gnathopods and the subequal rami of uropod 3.

From *Calliopius* Liljeborg it differs by the lack of inner lobes on the lower lip.

The genus is closely related to *Bouvierella* Chevreux, 1900 differing only by gnathopod 2 which has

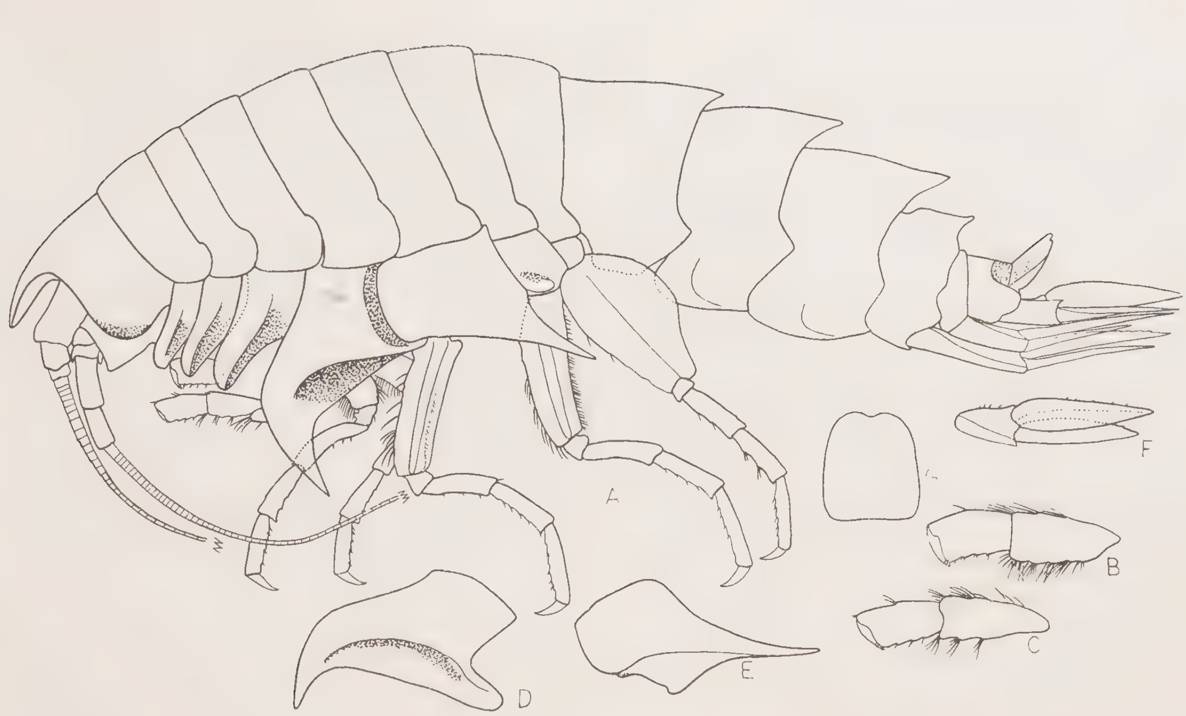

Fig. 72. *Epimeria glaucosa* n.sp. Female, holotype, 19 mm. St. 575. A, lateral view; B, C, gnathopods 1, 2; D, E, coxae 4, 5; F, uropod 3; G, telson.

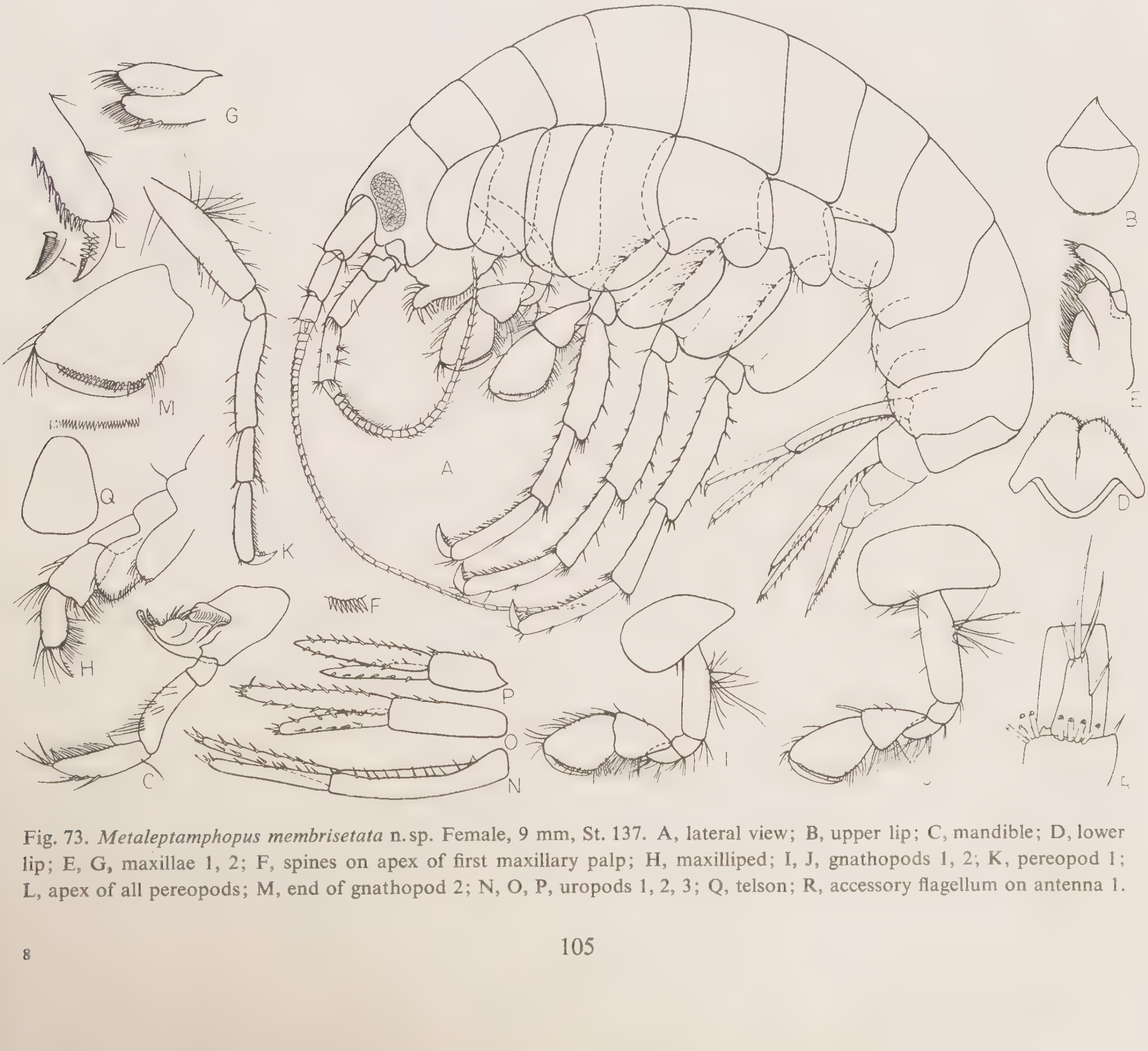

Fig. 73. *Metaleptamphopus membrisetata* n.sp. Female, 9 mm, St. 137. A, lateral view; B, upper lip; C, mandible; D, lower lip; E, G, maxillae 1, 2; F, spines on apex of first maxillary palp; H, maxilliped; I, J, gnathopods 1, 2; K, pereopod 1; L, apex of all pereopods; M, end of gnathopod 2; N, O, P, uropods 1, 2, 3; Q, telson; R, accessory flagellum on antenna 1.

article 5 shorter than 6 and by the rounded apices of both the telson and upper lip, which are incised slightly in *Bouvierella.*

In assigning the following new species to *Metaleptamphopus* it must be stated that several discrepancies exist. The new species bears a minute, uniarticulate accessory flagellum; its second maxilla has slightly more slender lobes; the maxillipedal palp is stouter and the female gnathopods are stouter, more like the male of the type species. It is probable that the new species should be made the type of a new genus, but the writer is reluctant to perform this operation until a third species, if it lives, is discovered and its relationship to the two, now known, determined. Of particular interest is the fact that the pereopodal dactyls are pectinate posteriorly in *M. pectinatus* and anteriorly in the new species.

Metaleptamphopus membrisetata n. sp.

(Fig. 73)

Material:

St. 137, off SW Africa, 20°04′S 11°56′E, 537 m, ST 300,23. XII. 1950. Holotype, female, 10 mm; figured female, 9 mm. Total: 2 specimens.

Diagnosis:

Accessory flagellum present; article 7 of pereopods 1-5 bearing anterior pectinations in the form of short spines and a distal membrane of closely packed setules; female gnathopods with stout sixth articles; maxillipedal palp stout and lobes of maxilla 2 more slender than in the type species.

The lower corner of the third pleonal epimeron in the figured female has a slight tooth but in the holotype the corner is quadrate.

FAMILY PONTOGENEIIDAE

Revival of the genus Dautzenbergia Chevreux, 1900

In the course of this research it has been brought to my attention that the species *Sympleustes grandimanus* (in CHEVREUX, 1900) is improperly classified. It was recently noted by BARNARD and GIVEN (1960) that this species and *S. dentatus* Chevreux, 1927 are atypical in their lower lips, which are more like those of Calliopiidae or Pontogeneiidae. In fact, *S. megacheir* Walker (see CHEVREUX 1927) also should be mentioned in this regard. Their lower lips, are not composed of tilted, oval outer lobes astride gaping fused inner lobes but instead are normal amphipod lower lips, composed of outer lobes with pointed mandibular processes and small inner lobes which do not separate the outer lobes greatly. On this basis, it is unwise to retain these three species in the Pleustidae. In addition, each species has a slightly cleft telson, about one third its length; this is not characteristic of pleustids. By removing such species from the Pleustidae, the diagnosis of that family may be narrowed and its members more easily recognized.

The condition of the telsons in these "sympleustids" requires them to be assigned to the Pontogeneiidae, rather than the Calliopiidae, a point of view not taken before. Once this is effected it seems clear that the species are indeed pontogeneiids, with their cleft telsons; that of *S. grandimanus* is formed into a v-shaped excision by the oblique apices and is reminiscent of many pontogeneiid genera, but never pleustids.

A prior generic name is available for these species, *Dautzenbergia* Chevreux 1900, with type species *Amphithopsis grandimanus,* the original name of "*Sympleustes*" *grandimanus* (see STEBBING 1906). The movements of the type species have been from *Amphithopsis* to *Sympleustes* to *Dautzenbergia* (by CHEVREUX 1900) and back to *Sympleustes* by SEXTON (1909) with the reduction of *Dautzenbergia* to *Sympleustes.*

In the Pontogeneiidae, *Dautzenbergia,* with its three species *D. grandimanus, D. dentatus* and *D. megacheir,* is closest to the genus *Bovallia* Pfeffer because the gnathopodal structure is not linear or sublinear and because of the short, lobed, fifth articles on the gnathopods and the short, scale-like accessory flagellum (see key to Pontogeneiidae in SCHELLENBERG 1929). *Dautzenbergia* has distinct inner lobes on the lower lip and much larger gnathopods than in *Bovallia.*

FAMILY LILJEBORGIIDAE

Liljeborgia mojada n. sp.

(Fig. 74)

Material:

St. 200, off Natal, 29°39′S 37°01′E, 5090-4880 m, Globigerina ooze, HOT, 17. II. 1951. Male holotype, 20 mm. Unique.

Diagnosis:

Eyes absent, lateral lobes of head narrow and blunt; antenna 1 short, reaching only slightly beyond end of article 4 on antenna 2; antenna 2 long; pleon segments 1 and 2 each with a tiny single dorsal tooth;

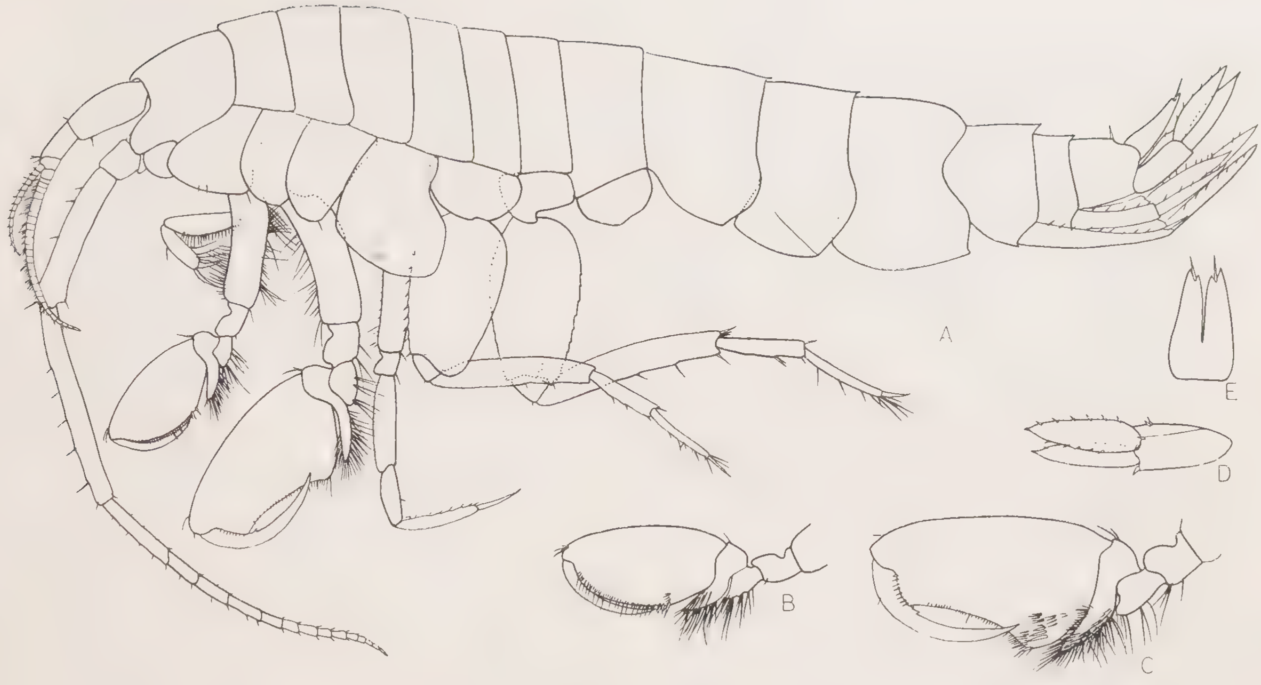

Fig. 74. *Liljeborgia mojada* n.sp. Male, holotype, 20 mm, St. 200. A, lateral view; B, C, gnathopods 1, 2; D, uropod 3; E, telson.

pleon segment 3 lacking a dorsal tooth; pleon segments 4 and 5 each with a medium-sized dorsal tooth; third pleonal epimeron convex posteriorly and bearing a small distal tooth; article 7 of gnathopod 1 lacking marginal notches but gnathopod 2 bearing 4 small notches; palm of gnathopod 2 excavate; telson cleft for two thirds of its length; epistome rounded in front; pereopods 3 and 4 (5 is missing) with ovate second articles, weakly serrate on posterior margins.

Relationship:

This species differs from another deep-sea one, *Liljeborgia zarica* J.L.Barnard, 1961 by the lack of a dorsal tooth on pleon segment 3. It differs from *L.consanguinea* Stebbing, 1888 (pl. 91) in the same respect. From *L.macronyx* Sars, 1895 (pl. 188, fig. 2) the new species differs by the more convex posterior margin of the third pleonal epimeron and the poorly developed notches on the gnathopodal fingers.

Liljeborgia mojada differs from *L.caeca* Birstein and Vinogradova, 1960 by the excavate palm of gnathopod 2 and the convex hind border of the third pleonal epimeron.

FAMILY GAMMARIDAE

Key to marine Gammaridae

Only those genera of Gammaridae with marine representatives are included in this key. Some generic pairs, such as *Maeropsis-Paraceradocus* and *Ceradocus-Ceradocoides* have not been separated by firm criteria and I am unable to provide distinctions between them. Other genera are cited twice in the key, where their structures are intergrading or variable.

1. Telson entire 2
1. Telson cleft 6
2. Telson not emarginate 3
2. Telson emarginate 4
3. Rami of uropod 3 long .... *Weyprechtia*
3. Rami of uropod 3 short .... *Parapherusa*
4. Inner ramus of uropod 3 longer than outer .... *Amathillopsis*
4. Inner ramus of uropod 3 shorter than outer 5
5. Pereon and pleon segments carinate .... *Gammarellus*
5. Pereon and pleon segments not carinate .... *Falklandella*

6. Accessory flagellum 1 or 2-articulate 7
6. Accessory flagellum 3 or more articulate 16
7. Inner ramus of uropod 3 scale-like and much smaller than outer 8
7. Inner ramus of uropod 3 nearly as large as outer 11
8. Outer ramus of uropod 3 biarticulate 9
8. Outer ramus of uropod 3 uniarticulate 10
9. Maxilla 2, inner edge of inner plate lined with setae .... *Eriopisa*
9. Maxilla 2, inner edge of inner plate unarmed .... *Eriopisella*
10. Uropod 3 extending well beyond the end of uropod 1 .... *Melita* (in part)
10. Uropod 3 not extending beyond end of uropod 1 .... *Melitoides* (in part)
11. Rami of uropod 3 foliaceous, oval, apically rounded .... *Megaluropus*
11. Rami of uropod 3 lanceolate or apices truncated, not foliaceous 12
12. Mandibular palp article 2 shorter than article 1 .... *Parelasmopus*
12. Mandibular palp article 2 longer than article 1 13
13. Gnathopod 1 subchelate .... *Anelasmopus*
13. Gnathopod 1 simple 14
14. Female gnathopod 2 simple .... *Cheirocratus*
14. Female gnathopod 2 subchelate 15
15. Antenna 1 nearly as long as antenna 2 .... *Cheirocratella*
15. Antenna 1 reaching only to end of peduncle of antenna 2 .... *Casco*
16. Pereon segments carinate .... *Gammaracanthus*
16. Pereon segments not carinate 17
17. Urosome with all 3 segments bearing bundles of spines; except one species of *Anisogammarus* bearing a tooth only on segment 2 18
17. Urosome occasionally with scattered spines not on all segments and not arranged in bundles, spines usually absent 20
18. Some segments anterior to pleon segment 4 bearing dorsal spines .... *Echinogammarus*
18. No segments anterior to pleon segment 4 bearing dorsal spines 19
19. Gnathopod 1 larger than 2, both gnathopodal palms bearing chisel-shaped spines *Anisogammarus*
19. Gnathopod 1 smaller than 2, palms not bearing chisel-shaped spines .... *Gammarus*
20. Inner ramus of uropod 3 scale-like, very small 21
20. Inner ramus of uropod 3 nearly as long as outer 22
21. Uropod 3 extending well beyond end of uropod 1 .... *Melita* (in part)
21. Uropod 3 not exceeding end of uropod 1 .... *Melitoides* (in part)
22. Rami of uropod 3 foliaceous, oval, apices rounded .... *Quadrivisio*
22. Rami of uropod 3 lanceolate, square or apices truncate 23
23. Maxilla 2, inner edge of inner plate not lined with setae 24
23. Maxilla 2, inner edge of inner plate lined with setae 26
24. Palp of maxilliped with 3 articles .... *Maerella*
24. Palp of maxilliped with 4 articles 25
25. Mandibular palp article 3 stout, falcate .... *Elasmopus*
25. Mandibular palp article 3 slender, not falcate .... *Maera*
26. Palm and hind margin of article 6 on gnathopod 2 not separated, article 7 of gnathopod 2 nearly as long as article 6, rami of uropod 3 equal to peduncle in length .... *Pherusa*
26. These characters not combined 27
27. Lower lip lacking inner lobes .... *Ceradocopsis*
27. Lower lip bearing inner lobes 28
28. Maxilla 1, inner edge of inner lobe not lined with setae 29
28. Maxilla 1, inner edge of inner lobe lined with setae 31
29. Outer ramus of uropod 3 bearing minute article 2 .... *Maeracunha* (in part)
29. Outer ramus of uropod 3 lacking second article 30
30. These genera probably identical .... *Maeropsis*

30. These genera probably identical .... *Paraceradocus*
31. Palm of gnathopod 1 transverse .... *Bathyceradocus*
31. Palm of gnathopod 1 oblique 32
32. Outer ramus of uropod 3 bearing minute second article 33
32. Outer ramus of uropod 3 lacking second article 34
33. Gnathopod 2 stouter than 1 .... *Maeracunha* (in part)
33. Gnathopod 2 more slender than 1 .... *Metaceradocoides*[1]
34. Male gnathopod 2 much stouter than gnathopod 1 .... *Ceradocus & Ceradocoides*
34. Male gnathopod 2 not stouter than gnathopod 1 35
35. Gnathopod 2, palm indistinct .... *Metaceradocus*
35. Gnathopod 2, palm distinct, nearly transverse .... *Metaceradocoides*[1]

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[1] BIRSTEIN and VINOGRADOVA 1960 (in part).

Bathyceradocus stephenseni Pirlot, 1934
(Figs. 75, 76)

Bathyceradocus Stephenseni Pirlot, 1934: 224-229, figs. 97-99; DAHL 1959: 239, fig. 20.

Material:

St. 232, Madagascar-Mombasa, 9°03'S 49°22'E, 4930 m, no sediment, HOT, 8. III. 51. One specimen, sex?, 14 mm, white in life.

St. 726, Gulf of Panama, 5°49'N 78°52'W, 3670-3270 m, clay, HOT, 13. V. 1952. Specimens removed from sunken tree trunk. 25 specimens. Figured specimen is 21 mm long; Largest is 36 mm.

St. 443, Mindanao Sea, 8°48'N 124°09'E, 1500 m, mud, many fragments of plants, ST 300, 16. VIII. 1951. Female, 15 mm, juvenile, 7 mm.

Remarks:

If the identifications are correct it would appear that this species ranges the Indo-Pacific Ocean abyss from Panama westward to Madagascar. PIRLOT's specimen came from the Moluccas Strait, 1165-1264 m and DAHL's from the Banda trench, 7290-7250 m. The species is obviously benthic, both by its phylogenetic position and by its removal from a sunken log, where it was feeding on the rotting wood. The stomach of one specimen was analyzed and found to contain comminuted woody material similar to that seen in isopod and amphipod woodborers of the genera *Limnoria* and *Chelura*.

Considerable variation occurs in the pleonal teeth of the present material as compared to that of PIRLOT. The variations are not consistent at the Panamanian locality, indicating no need at this time for subspecific segregation. The single Madagascar spe-

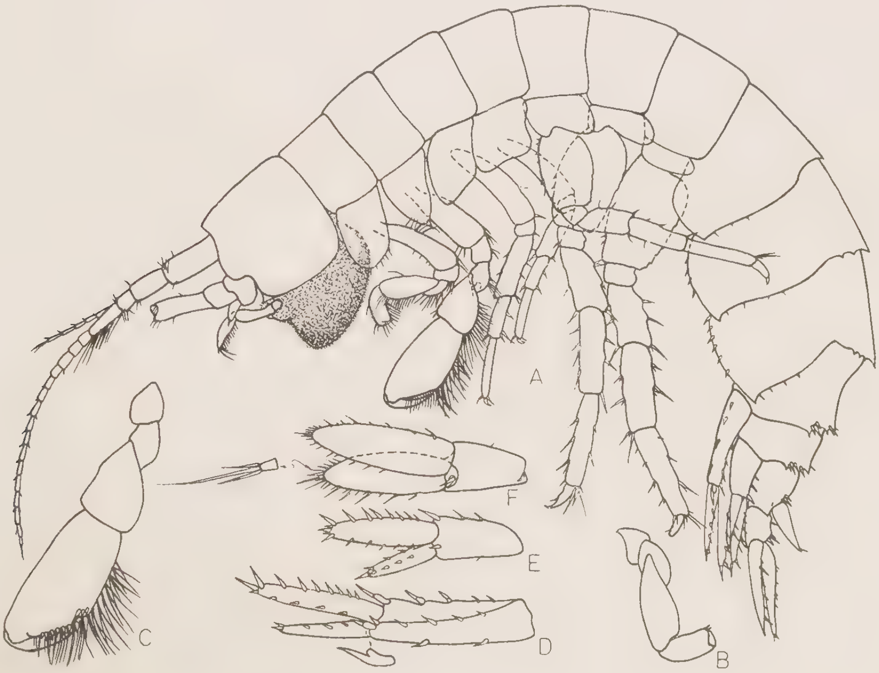

Fig. 75. *Bathyceradocus stephenseni* Pirlot. ?Sex, 14 mm, St. 232. A, lateral view, mouthparts covered with fuzzy growth of Protozoa; B, C, gnathopods 1, 2; D, E, F, uropods 1, 2, 3.

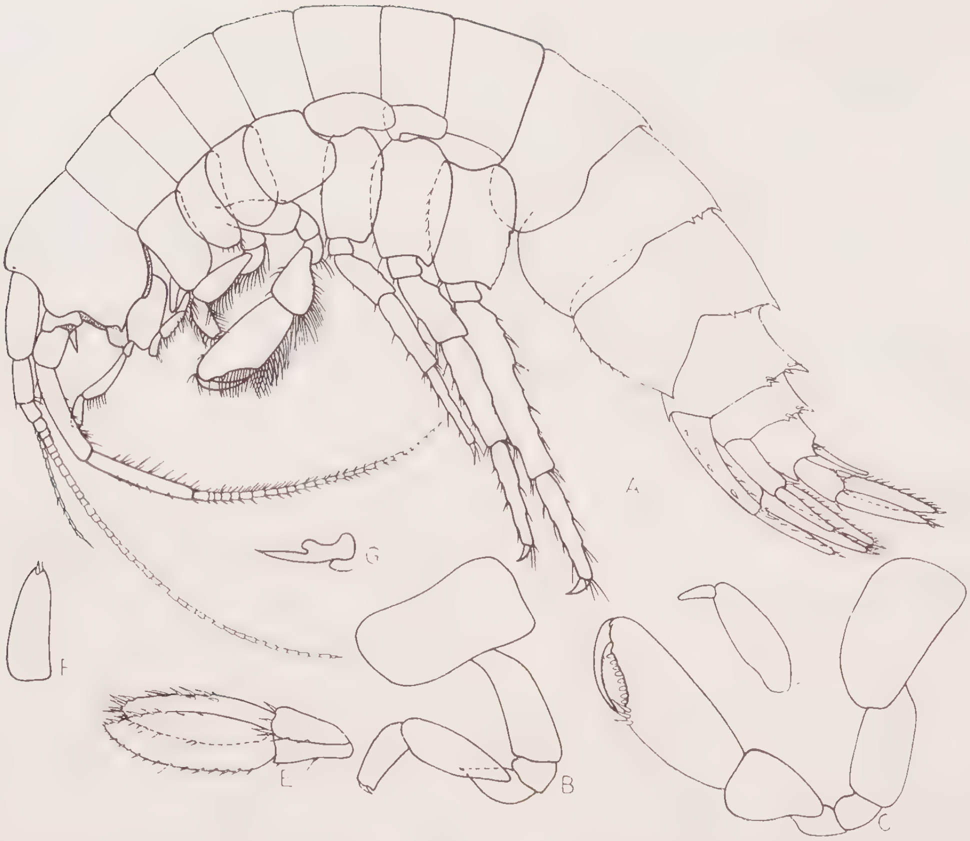

Fig. 76. *Bathyceradocus stephenseni* Pirlot. Male, 21 mm, St. 726. A, lateral view; B, C, gnathopods 1, 2; D, articles 3 and 4 of maxillipedal palp, setae not drawn; E, uropod 3; F, half of telson; G, peduncular spine of uropod 1.

cimen also differs from either the Moluccas or Panamanian representatives.

The Panamanian specimens are larger than PIRLOT's, with the second gnathopod better developed and similar to DAHL's figure of a large specimen. In every respect they appear similar to PIRLOT's figures, even to the peculiar spines on the distal ends of the first uropodal peduncles, except that pleon segment 1 lacks the dorsolateral accessory tooth. These might be considered a subspecies, considering the geographic separation, but the largest male, 36 mm, is aberrant in other respects. Pleon segments 2-3 also lack accessory teeth and pleon segments 4-5 bear only one accessory tooth instead of two. The third pleonal epimeron is not prolonged behind and scarcely toothed. Article 6 of gnathopod 2 is relatively shorter and stouter. The disto-lateral spine of the first uropodal peduncle is a normal, unnotched spine whereas the inner one is notched in the usual way. The lateral lobes of the head are poorly defined and the lower corner of the head is evenly rounded-quadrate. The maxillipedal palp is much more conspicuous than normally and projects as far forward as the mandibular palp. It appears, therefore, that age and phenotypy may have a bearing on the taxonomic features so that the writer hesitates to segregate these specimens as a subspecies.

The Madagascar specimen differs slightly from others in the species by its pleonal tooth formula, given in the table below. Coxa 4 also has a slightly different shape as seen in the figures. The third uropod has been drawn, since it was missing on PIRLOT's specimen. It has a minute second article on the outer ramus.

Of the Mindanao specimens, the adult female, 15 mm, shows a tooth formula identical to the type from Moluccas. The poorly developed formula of

Table 1. Accessory teeth on pleon segments of *Bathyceradocus stephenseni* in several different collections.

Pleon segment	1	2	3	4	5	6
PIRLOT 1934, Moluccas, 12 mm.......	1	2	2	2	2	0
Mindanao Sea, 15 mm..............	1	2	2	2	2	0
Mindanao Sea, 7 mm...............	0	0	0	2	1	0
Panamanian, normal, 21 mm.........	0	2	2	1	1	0
Panamanian, aberrant male, 36 mm...	0	0	0	1	1	0
Madagascar, 14 mm................	0	2	3	2	2	0

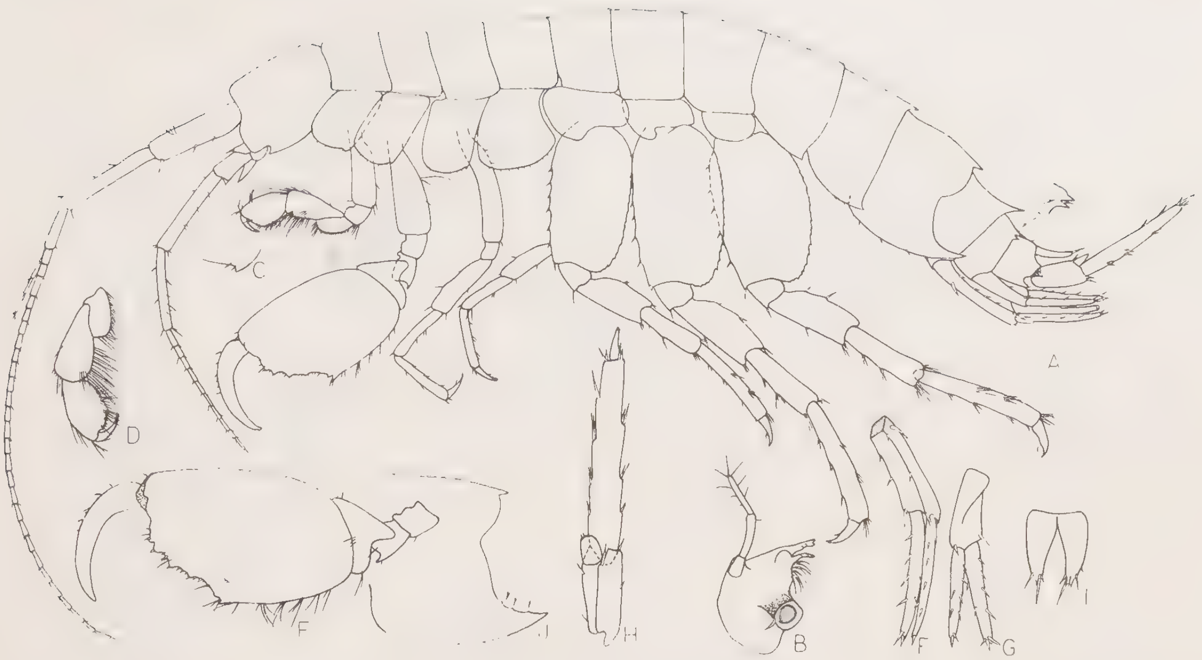

Fig. 77. *Melita lignophila* n. sp. Male, holotype, 6 mm, St. 745. A, lateral view; B, mandible; C, lower corner of coxa 1; D, E, gnathopods 1, 2; F, G, H, uropods 1, 2, 3; I, telson; J, third pleonal epimeron, arrows denoting minute serrations.

the juvenile indicates that advanced age and size are correlated with a higher formula.

Dahl (1959) shows a much more chelate first gnathoped than in any other specimens now assigned to the species and it may serve to identify hadal specimens as separate populations.

Distribution:

Gulf of Panama, 3670-3270 m; Strait of Moluccas, 1165-1264 m; Banda Trench, 7290-7250 m; Madagascar, 4930 m.

Melita lignophila n. sp.

(Fig. 77)

Material:

St. 745, Gulf of Panama, 7°15′N 79°25′W, 915 m, green clay, ST 600, 16.V.1952, on sunken tree trunk. Holotype male, 8 mm. Unique.

Diagnosis:

Eyes absent, lower corner of head with a sharp tooth below the lateral lobe; pleon segments 2, 3, and 4 with a posterior dorsal tooth, pleon segment 5 with 2 pairs of dorsolateral teeth, one pair on each side; third pleonal epimeron with a long slender tooth, which bears 3 poorly defined dorsal serrations; palm of gnathopod 2 irregularly and minutely sculptured, with a small defining tooth; mandibular palp very slender, mouthparts otherwise like *Melita palmata* (in Sars 1895: pl. 179).

Relationship:

This species differs from *Melita* (?) *solada* n. sp. by the dorsal teeth of pleon segments 2 and 3. It differs from *Melita dentata* (in Sars 1895: pl. 181, fig. 1) by the lack of eyes and the lack of accessory dorsal pleonal teeth. It differs from *M. abyssorum* Stephensen, 1944 and *Melitoides makarovi* (in Gurjanova, 1951, by the presence of dorsal metasomal teeth. The species is most closely related to *Melita richardi* (in Chevreux, 1900) and differs only by the absence of a dorsal tooth on pleon segment 1.

Melita? solada n. sp.

(Fig. 78)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20.I.1952. Holotype, female, 12 mm, figured.

Remarks on genus:

The present unique specimen lacks the third uropods and for this reason is not firmly assignable to any genus in the Gammaridae. By ignoring the immediate use of uropods in the previous key to the Gammaridae the species might be placed in *Cera-*

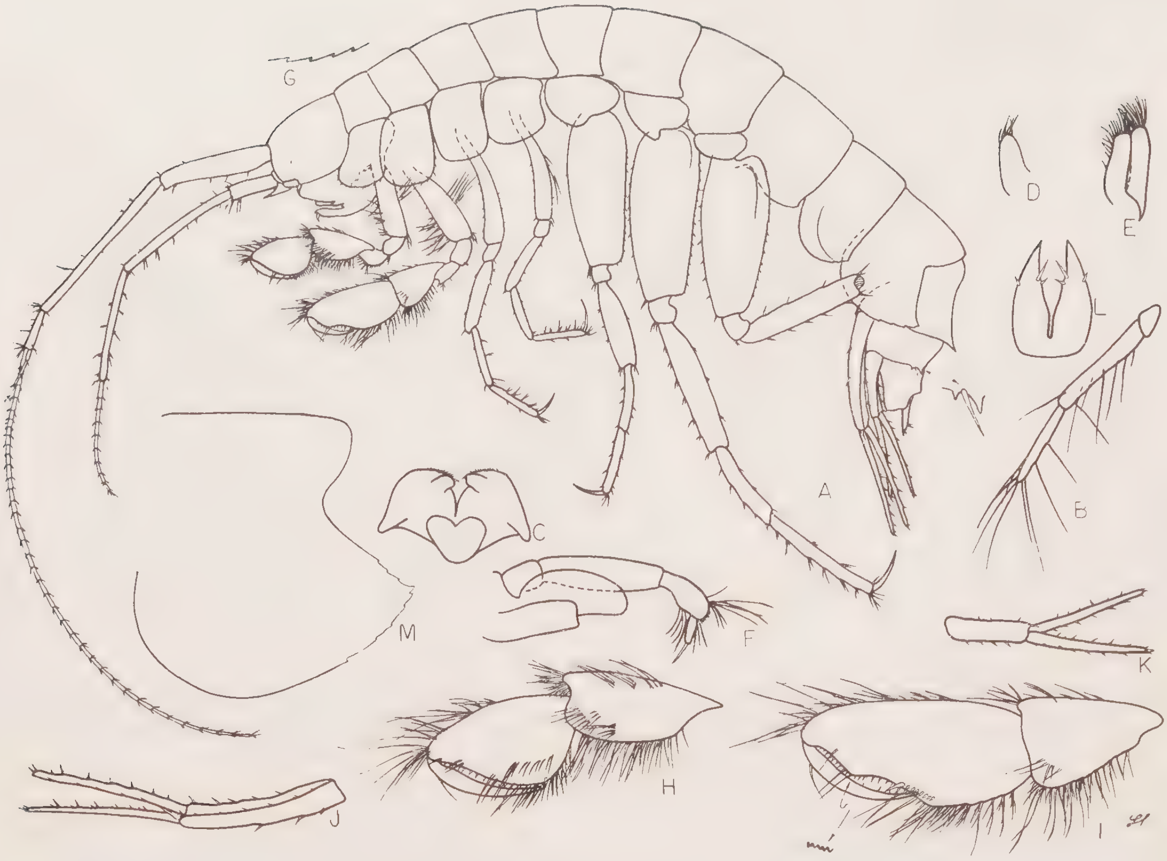

Fig. 78. *Melita? solada* n. sp. Female, holotype, 12 mm, St. 626. A, lateral view; B, palp of mandible; C, lower lip; D, inner plate of maxilla 1; E, maxilla 2; F, maxilliped, armature of plates not drawn; G, lower edge of coxa 1; H, I, gnathopods 1, 2, medial views; J, K, uropods 1, 2; L, telson; M, third pleonal epimeron.

docopsis Schellenberg, 1926a, especially for the lack of discernable inner lobes on the lower lip. The setae of the inner plate of maxilla 1 are not dense enough or placed properly for assignment to *Ceradocus* and its allies. The peculiar telson is the best indication that the species is a *Melita,* with the gaping lobes and the medial proximal notches on each lobe, characteristic of many *Melitas.* In this respect the species also fits the genus *Melitoides,* which differs from *Melita* largely by the short third uropod. The absence of both uropods in the present specimen, suggests, however, that it has very long ones, easily subject to loss.

The species might be assigned to *Maera,* particularly because of the poorly setose inner plate of maxilla 1 and will be distinguished from species in that genus in paragraphs below.

Diagnosis:

Eyes poorly represented, outlined by a nearly colorless mass of amorphous tissue; article 2 of second antenna 1.5 times as long as article 1; antennae long; gnathopod 2 of little taxonomic value because the animal is female, palm excavate on proximal half, distally bearing a low mound; no pereon or metasome segments carinate or toothed; pleon segment 4 (urosome segment 1) bearing a dorsal erect tooth; urosome segment 2 bearing two small lateral teeth on each side, enclosing a spine; third pleonal epimeron with lower and hind edges minutely but sparsely serrate, lower corner produced into a small tooth.

Relationship:

In its dorsal pleonal armature the species is much like *M. palmata* (see SARS 1895: pl. 179) but the first gnathopod of the female is quite different, not having a transverse palm. The new species differs from other blind or nearly blind bathyal species by the dorsal armature of the pleon segments or by the palms of the female gnathopods: *M. abyssorum* Stephensen, 1944 has a large defining tooth on the female palm; *M. richardi* Chevreux, 1900 has dorsal teeth on the metasome; *Melitoides makarovi* Gur-

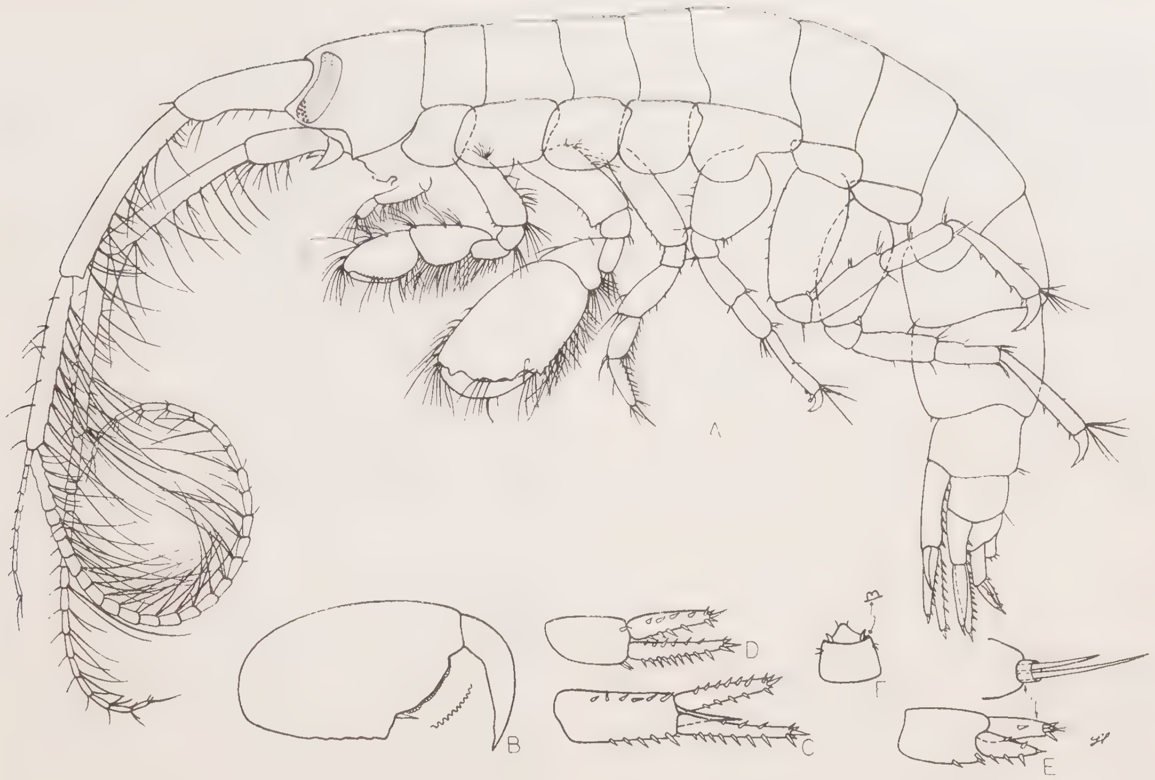

Fig. 79. *Eurystheus afer* (Stebbing). Male, 8 mm, St. 196. A, lateral view; B, gnathopod 2; C, D, E, uropods 1, 2, 3; F, telson.

janova (GURJANOVA, 1951) has a large dorsal tooth on pleon segment 5; *M. pallida* Sars (SARS, 1885) has dorsolateral teeth on the metasome segments; *M. quadrispinosa* Vosseler (GURJANOVA, 1951) has a middorsal tooth on pleon segment 5 as well as two laterals.

This species poses a special problem in its relationship to *M. orgasmos* K. H. Barnard, 1940, which it resembles closely. The dorsal pleonal armature is identical to that of *M. orgasmos* and the ventral serrations of the third pleonal epimeron also are mentioned by K. H. BARNARD, although he did not mention the posterior ones. The difficulty lies in BARNARD's statement that the female gnathopods are like *M. palmata* which, if using SARS (1895: pl. 179), are quite different than in the present specimen, the female first gnathopod bearing a transverse palm. Otherwise the present specimen would be assigned to that species.

Only three species of *Maera* bear a dorsal tooth on pleon segment 4. These are *Maera insignis, M. subcarinatus* and *M. odontoplax.* The new species differs from all by the lack of eyes and the presence of serrations on the third pleonal epimeron.

FAMILY PHOTIDAE

Eurystheus afer (Stebbing, 1888)

(Fig. 79)

Gammaropsis afer Stebbing, 1888: 1097, pl. 113.
Eurystheus afer, STEBBING 1906: 612; STEBBING 1908: 87; ?K. H. BARNARD 1916: 249-250, pl. 28, fig. 11; K. H. BARNARD 1937: 165-166, fig. 12.
Not *Eurystheus afer,* CHILTON 1912: 510-511, pl. 2, figs. 30-34.

Material:

St. 196, off Durban, 29°55'S 31°20'E, 430 m, sandy mud with stones, ST 300, 14. II. 1951. Two males, 8 mm, female, 9 mm.

Diagnosis:

Lateral lobes of head not strongly produced forward; eyes oblong, lower part more clearly seen than upper; gnathopod 2 with oblique palm, not deeply excavated or toothed, minutely castellate; dorsal edges of pleon segments smooth; third pleonal epimeron with posterior edge slightly convex, lower corner rounded.

Remarks:

STEBBING (1908) and BARNARD (1916) infer that *E. afer* and *E. atlanticus* (Stebbing, 1888) may be the same species but the writer believes not, for the lateral lobes of the head and the structure of the eyes are distinctive. BARNARD (1916) figured the male second gnathopod and again in (1937); the latter is more like the original description in the ameliorated cusp defining the palm. The present male specimens are more like the original description and figures than other references cited above.

Distribution:

Gulf of Suez and South Africa, surface to 430 m.

FAMILY COROPHIIDAE

The Corophiidae are a mixture of basic amphipod types, characterized essentially only by the dorsal body depression. Some have gnathopod 1 larger than 2 and vice versa; some are more dorsally depressed than others; some bear hooked spines on the telson; in most of them the third uropods are reduced to one ramus and the second antenna is as long as the first and often stouter. Thus, *Camacho* and the new genus *Aorcho* to follow are not typical of Corophiidae, except in the depression of the body and bear better resemblance to Aoridae or Photidae, especially to genera with a short second antenna. The circular telson is also an indication of this relationship. What should be remembered however, is that zoologists are not always able to categorize families precisely, for evolution often leaves intergrades and intermediates. See J. L. BARNARD (1958a) for a key to the family.

Aorcho n. gen.

Diagnosis:

Antenna 1 bearing a 4-articulate accessory flagellum; article 3 of peduncle as long as article 1; uropod 3 with equal sized rami which are longer than the peduncle; telson nearly circular; both pereon and pleon dorsally depressed, more markedly so than shown in accompanying figures for the pleon is especially tall; mouthparts of the general aorid-photid-corophiid type, identical to those of *Camacho* Stebbing, 1888 (pl. 127); gnathopods nearly equal in size, the first pair slightly stouter than the second.

Type species: *Aorcho delgadus* n. sp.

Remarks:

The writer hesitates in assigning the present genus and species to a family. It poses the same problem that some other corophiids do in their remarkable similarity to Photidae and Aoridae. For instance, the genus *Camacho* Stebbing, 1888 might easily be placed in the Photidae except that its body and especially urosome are distinctly depressed. Yet the genus *Bonnierella* Chevreux, 1900 placed in the Photidae and otherwise closely related to *Camacho* might be placed in the Corophiidae. *Aorcho* is very difficult to place because the gnathopods are so much alike. It would be difficult to choose between the Aoridae or the Photidae, if it were to be placed in either. If assigned to Aoridae it keys out to *Lembos,* but it is obviously not in that genus because its first gnathopods are not distinctly large although it bears close similarity to *L. longidigitans* Bonnier, 1896. In addition it has article 3 of antenna 1 as long as article 1, not typical of *Lembos*. If assigned to the Photidae it might be called *Eurystheus* but this genus almost invariably has gnathopod 2 distinctly larger than gnathopod 1.

Aorcho bears resemblance to *Paradryope* Stebbing, 1888 in the Aoridae by the long third article of antenna 1 but differs by the rami of uropod 3 which are longer than the peduncle whereas the reverse is the case with *Paradryope*.

Aorcho is distinct from *Bonnierella* which has gnathopod 2 distinctly larger than 1 and has a rudimentary accessory flagellum.

It differs from *Camacho* by the equal rami of uropod 3, whereas the inner ramus in *Camacho* is much smaller than the outer. It and *Camacho* should be placed together in the same family. No matter in which family it is placed, Corophiidae, Aoridae or Photidae, the genus represents a new one.

Aorcho delgadus n. sp.

(Fig. 80)

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Holotype, male, 7 mm. Figured specimen, male, 7 mm. Five other specimens, total 7.

Diagnosis:

With the characters of the genus.

Descriptive features:

The eyes are a transparent mass containing a few

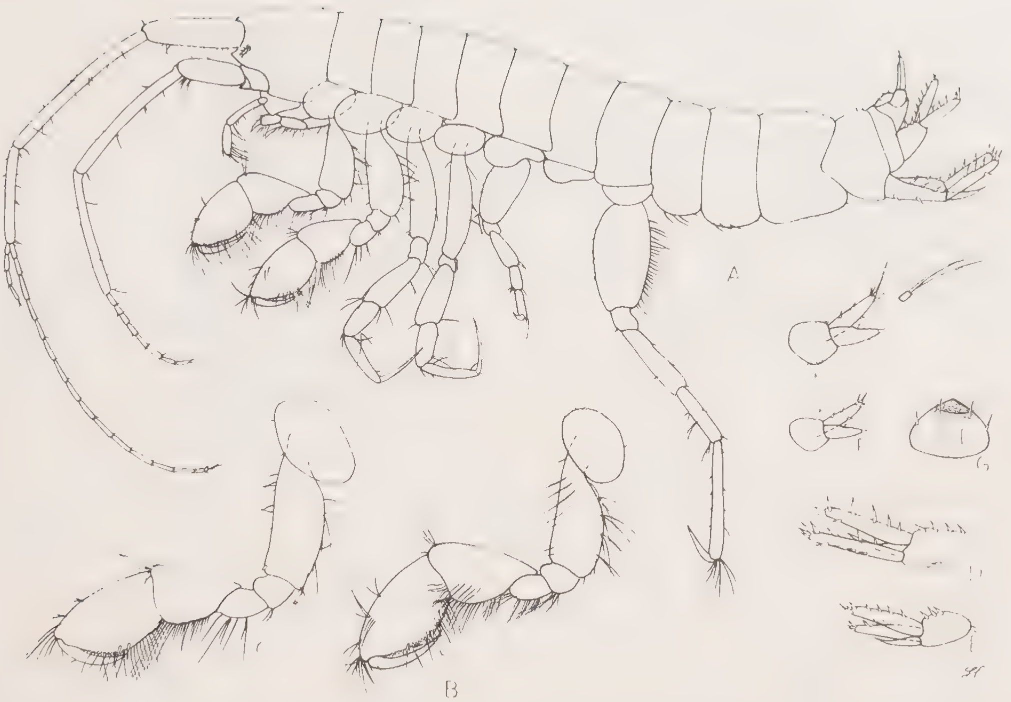

Fig. 80. *Aorcho delgadus* n. gen., n. sp. Male, holotype, 6 mm, St. 626. A, lateral view; B, C, gnathopods 1, 2; D, E, F, uropods 1, 2, 3; G, telson.

cellular globs. The female is identical to the male except for possessing brood plates. The peduncle of the pleopods is not expanded medially. The accompanying figures should suffice for a specific diagnosis, until another species is discovered in the genus, for which comparison may be made.

Camacho bathyplous Stebbing, 1888
(Figs. 81, 82)

Camacho bathyplous Stebbing, 1888: 1179, pl. 127; Stebbing 1906: 665; Stebbing 1908a: 87-88; Hurley 1954: 459.

Material:

St. 626, Tasman Sea, 42°10′S 170°10′E, 610 m, Globigerina ooze, PGI 0.2, 20. I. 1952. Figured, sex?, 8 mm, and 7 other specimens. Total: 8 specimens.

St. 665, Kermadec Trench, 36°38′S 178°21′E, 2470 m, grey clay, HOT, 25. II. 1952. Figured male, 13 mm.

St. 668, Kermadec Trench, 36°23′S, 177°41′E, 2640 m, clay, HOT, 29. II. 1952. Male, 13 mm.

Remarks:

The figured specimen from St. 626 is complete in at least one set of parts and is redrawn completely except for the mouthparts which correspond to Stebbing's (1888) figures. Stebbing (1908a) added more information to his original description and I am able to add a figure of antenna 1 which has a 4-articulate accessory flagellum. Uropod 3 has a second minute article on the outer ramus. The eyes are poorly developed and consist of a bundle of translucent globs. The lower corner of the head is acutely produced, not always visible, because of damage or bending. The fifth articles of gnathopods 1 and 2 are shorter than in the type specimen.

The figured specimen of St. 665 is in better condition, having pereopods 3-5 intact and figured in place. The animal is more heavily chitinized and the eyes are not visible; the lower corner of the head is much less produced than in the other specimen; for these two reasons it is more like the type specimen described by Stebbing.

Distribution:

This is a eurybathic species ranging in depth from 77 m on Agulhas Bank, off South Africa through 421 m off Lion's Head, New Zealand, and 610 m in the Tasman Sea through 2011 m off the east coast of New Zealand to 2640 m in the Kermadec Trench. It is a distinctly benthic species, both by its phylogenetic position and the silty materials found in the gut of the specimen from St. 665.

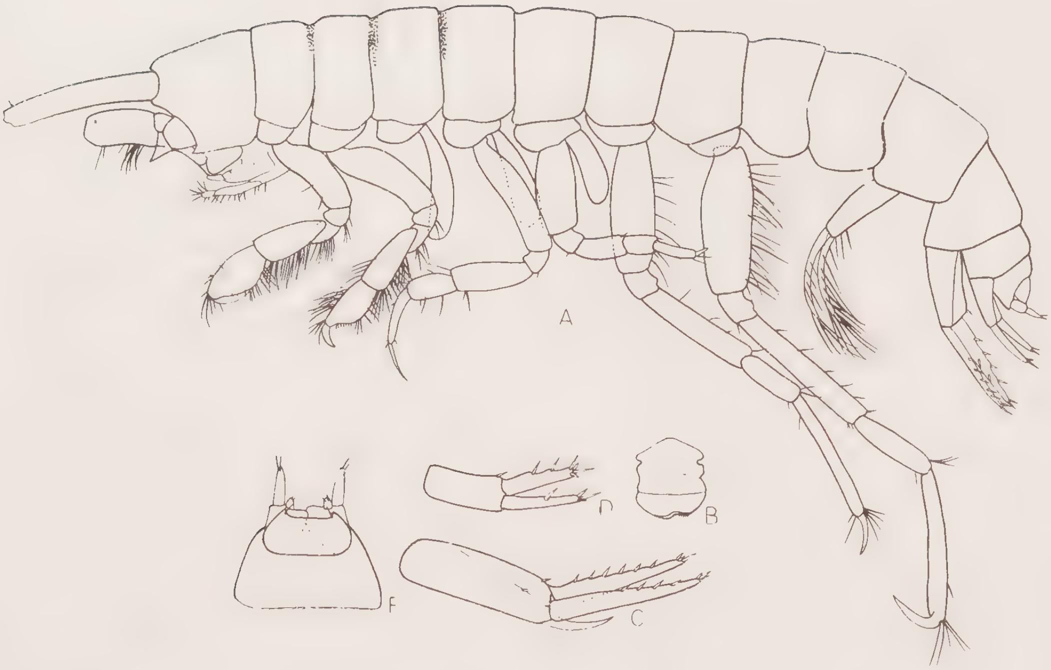

Fig. 81. *Camacho bathyplous* Stebbing. Male, 13 mm, St. 665. A, lateral view; B, upper lip; C, D, uropods 1, 2; E, dorsal view of pleon segment 6, telson and third uropods.

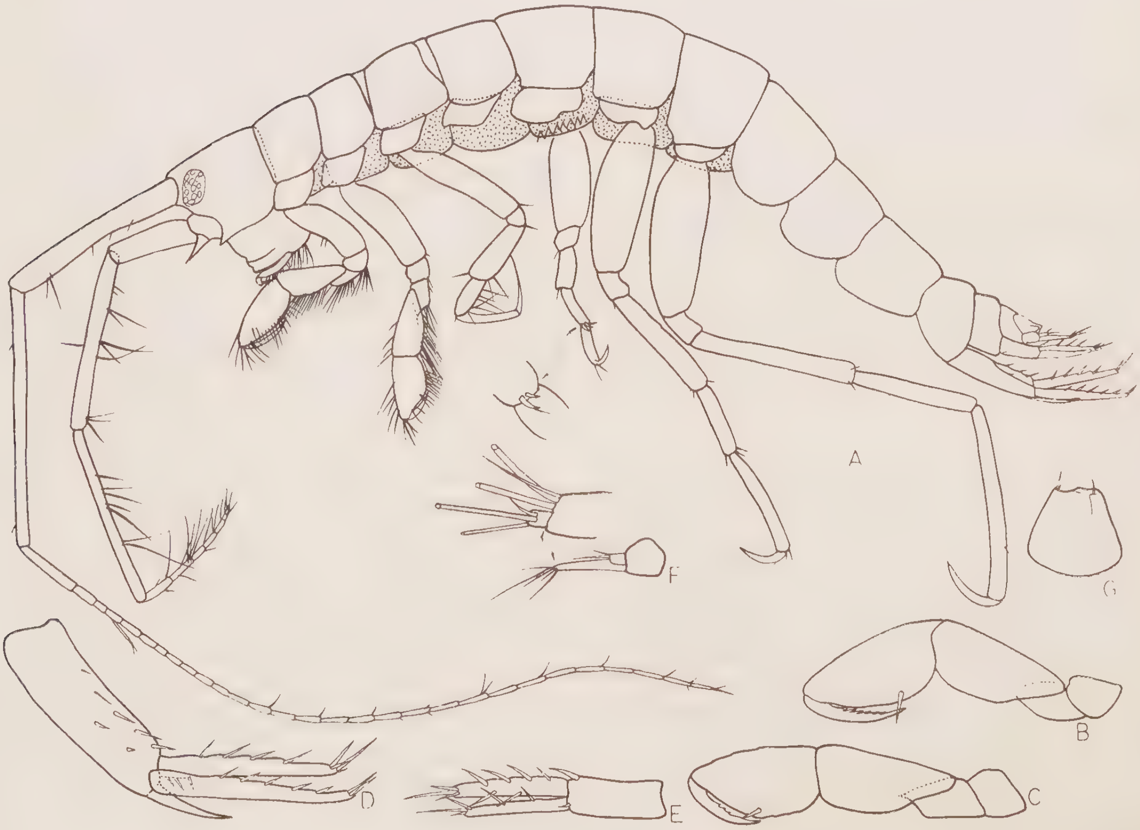

Fig. 82. *Camacho bathyplous* Stebbing. ?Sex, 8 mm, St. 626. A, lateral view, pereopod 3 restored to body; B, C, gnathopods 1, 2; D, E, F, uropods 1, 2, 3; G, telson.

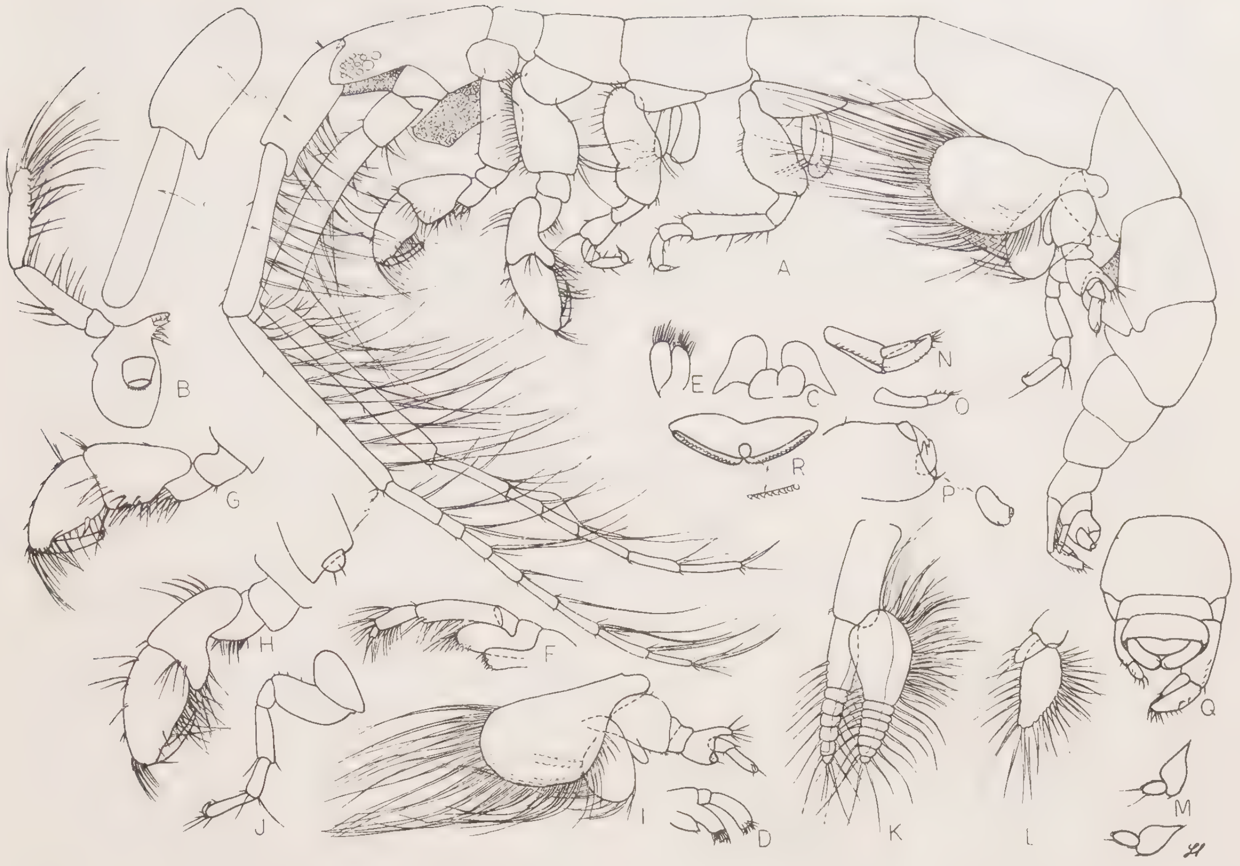

Fig. 83. *Runanga coxalis* n. gen., n. sp. Female, holotype, 5.5 mm, St. 626. A, lateral view; B, mandible; C, lower lip; D, E, maxillae 1, 2; F, maxilliped; G, H, gnathopods 1, 2; I, pereopod 3; J, pereopod 5; K, L, M, pleopods 1, 2, 3; N, O, P, uropods 1, 2, 3; Q, dorsal view of urosome; R, telson.

Cerapus abditus Templeton, 1817

Cerapus abditus Templeton, Pirlot 1938: 349-352, figs. 157-158 (with literature).

Material:

St. 196, off Durban, 29°55′S 31°20′E, 430 m, sandy mud with stones, ST 300, 14. II. 1951. Two females, 7 mm.

Distribution:

South Africa, Arabia, India, Indonesia, Australia, 13 to 430 m.

FAMILY PODOCERIDAE

Runanga n. gen.

Diagnosis:

Antennae subequal in length; antenna 1 bearing a vestigial, scale-like accessory flagellum; pleon bearing 6 distinct segments; three pairs of uropods are present, the first biramous, the second uniramous, the third essentially only a peduncle with vestigial, microscopic remnants of two rami, the inner ramus scale-like, the outer bearing two hooks; pleopods progressively vestigiate, the first normal, with two large rami, the second with the inner ramus shortened, the third apparently with only a single, minute ramus (it is possible, in dissection that an outer ramus was broken off; these organs are very fragile); coxa 5 foliaceous and densely setose; third mandibular palp article as long as second article.

Type species: *Runanga coxalis* n. sp.

Relationship:

This remarkable genus bears no distinct relationship to any of the known Podoceridae. It has the same general appearance as *Xenodice* Boeck and *Neoxenodice* Schellenberg but differs from them by the uniarticulate second uropod, among many other characters.

Runanga has a number of interesting morphological characters. The third, fourth and fifth pereon segments are unusually elongated; coupled with the smallness of the brood lamellae it might seem difficult for the animal to retain its ova in a brood pouch. It appears that some of this difficulty is ameliorated through the greatly setose, foliaceous expansion of the fifth coxa into a false brood lamella. The structure and size reduction of the last two pairs of pleopods is also worthy of note, features uncommon to marine amphipod genera. The gills and true brood lamellae are divorced from the basal attachment of the pereopods.

Runanga coxalis n. sp.

(Fig. 83)

Material:

St. 626, Tasman Sea, 42°10'S 170°10'E, 610 m, Globigerina ooze, PGI 0.2, 20.I.1952. Holotype, female, 5.5 mm.

Diagnosis:

With the characters of the genus.

First antennal article bearing a distal tooth, seen more clearly in flattened view, as drawn; article 2 of the second gnathopod with anterior edge greatly setose and prolonged proximally; article 4 of pereopod 2 more than twice as long as its counterpart on pereopod 1; head with minute rostrum, lateral lobes subacute, bearing scattered large and small ommatidea; posterior edge of telson armed with small hooked beads.

THE DISTRIBUTION OF ABYSSAL BENTHIC AMPHIPODS

Statistical Information

Barnard (1961)[1] presented a summary of known abyssal and hadal Amphipoda. With the addition of the *Galathea* analyses new totals are now necessary. A total of 272 species has now been reported from abyssal depths or greater. Of these 106 are definitely pelagic species and many may prove to live only in bathyal[2] waters which are fished by the abyssal hauls. Until open-closing nets are used extensively these species may not be sorted out. Another 7 species are probably abyssopelagic, rather than benthic. Sixteen species are inquilinous forms, of which only four are known to be definitely benthic in habitat, the others possibly inhabiting pelagic hosts, such as tunicates or medusae. A total of 81 definitely benthic species is known. Another 78 species are probably benthic, rather than pelagic, although this list includes some known demersals such as six species of *Rhachotropis*.

The 272 abyssal[2] species are distributed among 136 genera, of which 43 are known to be pelagic, 37 are known definitely to be benthic, 43 are suspected of being benthic, and the remaining 13 are problematical. Of the 136 total genera, 28 are abyssally endemic, but only 6 of these are known to be benthic (Table 7), although a few others are certainly good candidates for demersal behaviour. The distribution of the 37 benthic genera is partitioned among 6 abyssally endemic, 11 endemic to bathyal and greater depths (200 m), while the remaining 20 genera are primarily sublittoral, with an average of 23 species each, of which only 2.7 species per genus have been recorded abyssally. Thus, half of the species in the abyssal fauna belong to sublittoral genera, for 42 of the 81 known benthic species belong to the 20 sublittoral genera, and 19 more belong to primarily bathyal genera, leaving 20 species belonging to 14 primarily abyssal genera.

Barnard (1961) has shown that monotypism is quite high (92 %) in endemic abyssal amphipod genera. This includes pelagic genera as well as benthic. Nevertheless, the species in endemic abyssal genera comprise only 30 % of the total endemic abyssal species, the remaining 70 % belonging to genera found also in the bathyal and sublittoral.

The total number of bathyal monotypic genera is 47, of which 21 are benthic, leaving 125 monotypic sublittoral genera, most of which are benthic. Thus, as one progresses downward into the deep-sea, the number of monotypic genera decreases, but what is more striking is that the ratio between pelagic and benthic monotypic genera increases. Only 24 % of the abyssal monotypic genera are definitely benthic (perhaps 50 % including demersals when so determined in the future).

Regional endemism

Two extremes of opinion must be resolved concerning the distribution of abyssal faunas: the first is the belief that the species should be largely cosmopolitan

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[1] Paper in press.

[2] The writer defines marine benthic zones according to arbitrary depths, regardless of temperatures, as follows: *sublittoral* – 0-200 meters, *bathyal* – 200-2000 meters, *abyssal* – 2000-6000 meters, *hadal* – 6000 + meters. See Hedgpeth, 1957, Classification of Marine Environments, Chapt. 2, Treatise on Marine Ecology and Paleoecology, Geol. Soc. Amer., Mem. 67, vol. 1: 17-28.

Table 2. List of Arctic-North Atlantic abyssal benthic species; all are eurybathic except those marked with asterisks, which are largely unique records.

Dulichia abyssi
Dulichia nordlandica
Haploops setosa
Haploops similis
Harpinia amundseni
Hippomedon holbolli
Hippomedon longimanus
*_Ischyrocerus tenuicornis_
Leptophoxus falcatus
Liljeborgia fissicornis
*_Melita abyssorum_
Melita pallida
*_Melita richardi_
Neohela monstrosa
*_Orchomenella abyssalis_
Sympleustes megacheir
Unciola laticornis
*_Westwoodilla abyssalis_
Urothoe elegans
Unciola petalocera

because of the uniform abyssal environment, the second that regional endemism exists and can be proved to be correlated with barriers formed by continental and undersea topography, or with distance, because of low dispersal rates.

The most extreme continental barrier today is the separation of middle Atlantic and the middle Pacific faunas at the Panamanian isthmus, but a comparison of abyssal Amphipoda is not possible because of the lack of study. Another striking barrier is formed by the shallow straits of the Polar Sea between the North Pacific and North Atlantic oceans. Here surface temperatures approximate abyssal temperatures, but there is little evidence that abyssal amphipods have used this as an interconnecting pathway. The abyssal benthic amphipods of the North Pacific still remain to be described for the papers of BIRSTEIN & VINOGRADOV have been concerned with abyssal pelagic amphipods. Although a number of bathyal amphipods of the Polar Sea have been recorded by GURJANOVA (1951) none has been recorded from the abyssal Atlantic, indicating little emergence or submergence of amphipod faunas with isotherms. Most of the abyssal benthic amphipods recorded from the Norwegian and northeastern Atlantic basins have been optimally sublittoral types which have strayed into abyssal depths.

The evidence for regional endemism must be based, for the present on admittedly incomplete faunal analyses of various neighbouring and widely separated abyssal basins. The most striking aspect of the evidence supporting regional endemism is the high rate of recovery of new benthic species by each abyssal expedition and the low recovery of previously described species from other regions.

Even if undersea topographic barriers were ineffective then distance alone would be a barrier to dispersal provided that dispersal rates were low among obligatorily benthic amphipods. The fact that no proven stenobathic abyssal obligatorily benthic amphipod has yet been discovered with a wide, ocean-to-ocean distribution indicates that some kind of barrier exists to prevent the successful population of all abyssal regions with a few common types. Of the four species in Table 6, only _Neoxenodice caprellinoides_ is a legitimate candidate for the category of abyssal ubiquity, but it has not been recovered in the northern Hemisphere. Species of the genera _Onesimoides_ and _Bathyceradocus_ are associated with wood and may be transported with it. The species we are interested in are those which must be dispersed by their own benthic saltation and "population pressure".

Harpinia excavata and its varieties of the bathyal and abyssal regions in the eastern Atlantic represent an obligatorily benthic species with interbasin distribution but the species is eurybathic. When denoting "eurybathy" one usually thinks of a species that is relatively unrestricted in its dispersal mechanisms, for it is able to occupy wide ranges of depth and temperature. It is intriguing to suggest that _Harpiniopsis sanpedroensis_ J. L. Barnard, 1960a is an eastern Pacific subspecies or variety of _Harpinia excavata_. If more eastern Pacific materials can be examined and this thesis proved, then systematists must take a closer look at bathyal faunas in search of species widely dispersed among the several oceans. The writer has already mentioned herein the similarities of several species of bathyal _Ampelisca_, which may prove to be merely interocean races or varieties.

The _Galathea_ collections, by the addition of 22 new abyssal and 38 new bathyal species to the world fauna and the low recovery of previously known obligatorily benthic amphipods in these depths, demonstrate that high diversity and regional ende-

Table 3. List of benthic abyssal species known from one record

Anoediceros hanseni mozambis
Bathymedon candidus
Bogenfelsia incisa
Bonnierella angolae
Byblis ceylonica
Haploops abyssorum
Haploops lodo
Harpinia curtipes
Harpinia wandichia
Hippomedon antitemplado
Hippomedon concolor
Hippomedon tasmanae
Lembos lobata
Lepidepecreum clypodentatum
Leptophoxoides molaris
Leucothoe panpulco
Liljeborgia caeca
Liljeborgia mojada (1800 m)
Liljeborgia zarica (1800 m)
Metaceradocoides vitjazi
Onesimoides carinatus
Oediceroides forensia
Oediceroides zanzabaricus
Paradryope orguion
Paronesimoides lignivorus
Photis coecus
Podoceropsis lapisi
Urothoe simplignathia

Table 4. List of benthic abyssal species known from two or more records but from only one basin or region

Ampelisca byblisoides
Byblisoides arcillis
Carangolia mandibularis
Harpinia brevirostris
Harpinia cinca
Harpinia laevis capensis
Harpinia pacifica
Harpinia spaercki (hadal)
Hippomedon serratipes
Leucothoe rostrata
Orchomenella affinis
Orchomenella cheuvreuxi
Orchomenella dilatata
Urothoe rotundifrons
Urothoe vemae

mism exist, discounting demersal and pelagic species.

As new records of abyssal benthic amphipods are collected the trend appears to suggest that more and more species are widely distributed and that ubiquity is the rule, but this is not the case. It would appear that widely separated captures of benthic amphipods concern those that are eurybathic or those that are dispersed by special mechanisms. For instance, *Camacho bathyplous,* captured again by the *Galathea* appears to be eurybathic, and *Bathyceradocus stephenseni* now known from Panama west to Madagascar is greatly eurybathic, ranging from bathyal to hadal depths; probably, it is aided in its dispersal by its association with wood. The same statement is true of *Onesimoides chelatus.* Other species such as *Pseudonesimus abyssi,* though belonging to the Gammaridea, nevertheless probably are bathy- and abyssal-pelagic which conditions themselves are partially synonymous with ubiquity.

The distinctly benthic amphipods are in the families Ampeliscidae, Haustoriidae, Phoxocephalidae, Oedicerotidae, Liljeborgiidae, Photidae, Aoridae, and Corophiidae. Some of the male Phoxocephalidae swarm in upper water layers, but so far no blind abyssal species has been found at the surface. These benthic amphipods plus two or three genera of other families known to be benthic have been arranged into five groups in Tables 2 to 6. The last four groups (Tables 3 to 6) are composed of species known from low latitudes, as contrasted with Table 2, which concerns species known from the high north-Atlantic and Arctic basins, most of which are eurybathic. I have temporarily restricted the use of the term eurybathic in these cases to abyssal species which range up into bathyal depths shallower than 1200 m. Many of the Arctic and sub-Arctic abyssal species are known from depths shallower than 500 m and some are as shallow as the sublittoral. With the exception of *Orchomenella abyssorum* no Arctic-north Atlantic species is found in low latitudes of the abyss, which certainly is an exception to the idea that the cold abysses of the world are populated by species evolving in the rich, shallow cold Arctic and sub-Arctic. Indeed, the eurybathic abyssal faunas of the Norwegian and Polar Basins are unique to those areas. Some of the eurybathic Arctic genera, such as *Dulichia, Ischyrocerus, Leptophoxus, Sympleustes,* and *Unciola* are not found in other abyssal regions. Except for *Neohela,* the writer believes that most of the species in the Arctic genera are optimally sublittoral and bathyal. They stray into abyssal depths but have been unable to migrate into low latitudes by this pathway.

Tables 3-6 list 58 abyssal amphipod species, outside the Arctic-north Atlantic regime, largely from low latitudes, of which 50 are known from a single record, a single basin or a single region of two or three basins. Only 8 of the species are widely distributed, and of these 4 are eurybathic, with records in the shallow bathyal. This would indicate a relatively high degree of regional endemism in abyssal depths.

Collections of abyssal and hadal amphipods have been widely scattered through the ocean basins. SVERDRUP, JOHNSON and FLEMING (1942, Chart 1) listed 45 major basins and 17 trenches. On the basis of the work by the *Vema* (BARNARD 1961) each neighbouing basin of the south Atlantic had a relatively high number of endemic amphipods. The writer presumes that any one basin might have at least the following endemic specific composition: 2 ampeliscids, 2 phoxocephalids, 2 haustoriids, 2 corophiid-photids, one liljeborgiid, 2 lysianassids, and one other species, for a total of 12 species per basin. This would indicate that a minimum total of 540 abyssal benthic amphipod species exist in the 45 major basins, of which expeditions have now captured about 61 (including the writer's estimate of legitimate Arctic species). Perhaps the estimate is too high and it will be found that some species range through two or three neighbouring basins or that some species now known only by captures in

Table 5. List of benthic abyssal species which are eurybathic, occurring both at abyssal depths and shallower than 1200 m. Asterisks indicate species limited to a basin or region.

**Ampelisca abyssicola*
**Ampelisca gibba*
**Byblis serrata*
Camacho bathyplous
**Haploops vallifera*
**Harpinia abyssi*
Harpinia excavata & var.
?Leucothoe tridens
Mesopleustes abyssorum
**Metaphoxus "typicus"*
**Onesimoides cavimanus (hadal)*

Table 6. List of stenobathic abyssal species which are widely distributed, but not occurring shallower than 1200 m. Asterisk denotes deep bathyal to hadal distribution, hence eurybathic in depths greater than 1200 m.

**Bathyceradocus stephenseni*
Neoxenodice caprellinoides
Onesimoides chelatus
?Oediceroides wolffi

the deep bathyal will be found to be abyssal also; outside of the Arctic region, however, the latter case will be of rare occurrence, for the amphipods of bathyal regions are poorly studied.

One of the difficulties in using amphipods for biogeographic studies is that their habitats are poorly known. BARNARD (1961) listed 69 potentially benthic abyssal amphipods, beside those definitely known to be benthic. The writer believes that 4 species of *Hippomedon,* 4 of *Orchomenella* and 3 of *Leucothoe* from the inquilinous list be added to the distinctly benthic list. Nine new potentially benthic species are added in this report, for a total of 67 probable benthic species. It is now recognized that some of the 67 species are undoubtedly demersals of strong pelagic character such as species of *Andaniotes* and *Pseudonesimus.* These are genera or species widely distributed because of their primarily pelagic habits, but they often feed on the bottom. Probably all species of *Lepechinella* should be transferred to a list of demersals, except that they are more oriented to the benthic than to the pelagic. The term demersal as applied to amphipods would have a spectrum ranging in extreme from species nearly obligatorily benthic to those nearly obligatorily pelagic. It appears that species of *Lepechinella* are regionally endemic, for none has been found to be widely distributed. Counting one new species described herein there are now four species of abyssal *Lepechinella.* The remaining eight lepechinellids are bathyal but again regionally endemic. If the lepechinellids and the other 63 potentially benthic abyssal species were added to Tables 2-6 they would be distributed as follows: Arctic 17, one record 29, one region 14, eurybathic 4, and widely distributed stenobathic 3. Thus, only seven of the 67 species are widely distributed, which is good evidence that many of them are really benthic, and so not as widely dispersed as are pelagic organisms.

The origin of abyssal benthic amphipods

Two pairs of viewpoints concern the origin of abyssal amphipods: first, whether abyssal species originate in cold polar seas and submerge in low latitudes in the abyss or whether the faunas of each abyssal basin are more closely related to the bathyal and sublittoral areas nearby; second, whether the degree of specialization of abyssal faunas in terms of specific and generic endemism is a measure of the relative age of abyssal faunas. These points are related to but not quite synonymous to the other two extremes stated at the beginning of this discussion.

In the first case, it has already been mentioned that the benthic amphipod species known from abyssal polar areas have not been collected from the abyss in low latitudes and that most of the Arctic genera have not dispersed elsewhere. In the southern Hemisphere there is one interesting case, as reported herein, of three closely related species in the genus *Byblisoides,* which show submergence in low latitudes, with the Antarctic species at about 200 m, the temperate species at 600 m and the tropical species at 1600-2000 m. Perhaps other examples will be discovered, especially among those species not as yet proved to be benthic.

The development of endemic abyssal benthic genera has been quite low. BARNARD (1958) listed 516 marine gammaridean genera, of which only 28 are known to be abyssally endemic, but only 6 of these are definitely benthic. Among these the genus *Leptophoxoides* is closely related to the polar *Leptophoxus,* whereas the other four genera are indistinctly related to any shallow water genera, as now known.

Determining the closest relative of any individual abyssal species is a difficult job and often open to argument among taxonomists. One of two alterna-

Table 7. List of endemic abyssal benthic amphipod genera, 2000 + meters.

Bogenfelsia
Leptophoxoides
Metaceradocoides
Neoxenodice
Paradryope
Paronesimoides

List of endemic bathyal-abyssal benthic amphipod genera, 200 + meters.

Including only those genera with both abyssal and bathyal species. The writer's interpretation is that the genera *Bathymedon, Leptophoxus* and *Oediceroides* are normally bathyal or deeper, but that eurybathic strays occur in the Arctic and Antarctic sublittoral.

Anoediceros
Bathymedon
Bathyceradocus
Bonnierella
Byblisoides
Camacho
Carangolia
Leptophoxus
Mesopleustes
Neoxenodice
Oediceroides

Table 8. List of genera with abyssal benthic species.

	No. of species		
	Abyssal	Bathyal	Sublittoral
Ampelisca	3	21	68
Anoediceros	1	1	–
Bathymedon	2	8	5
Bathyceradocus	1*	–	–
Bogenfelsia	1	–	–
Bonnierella	1	2	–
Byblisoides	1	2	–
Byblis	2	8	11
Carangolia	1	1	–
Camacho	1*	–	–
Haploops	6	3	4
Dulichia	2	6	9
Harpinia	10	14	13
Hippomedon	7	8	12
Lembos	1	1	26
Ischyrocerus	1	7	17
Lepidepecreum	1	3	6
Leptophoxus	(1)	1	–
Leptophoxoides	1	–	–
Leucothoe	4	2	16
Liljeborgia	3	3	18
Melita	3	2	30
Mesopleustes	1*	–	–
Metaceradocoides	1	–	–
Neoxenodice	1	–	–
Onesimoides	3*	–	–
Neohela	1*	–	1
Oediceroides	4	10	9
Orchomenella	5	4	21
Paradryope	1	–	–
Paronesimoides	1	–	–
Photis	1	1	33
Podoceropsis	1	2	9
Sympleustes	1	4	11
Unciola	2	1	12
Urothoe	4	1	17
Westwoodilla	1	1	7
Totals	81	117	355

() = record of bathyal in abyssal.
* = eurybathic.

tives is the objective: whether an abyssal species is more closely related to a geographical neighbor in the bathyal-sublittoral or whether it is more closely related to another abyssal species in another geographic area. The second alternative would support the thesis that abyssal species evolve from one precursor already adapted to the abyssal environment and that radiation took place only at abyssal depths; this would mean that special morphological characteristics borne by the precursor have been carried over into the descendent species and are recognizable as unique determinants. Little evidence of this is present in amphipods. The answer to the alternatives has to be based on polymorphic genera with numerous shallow water species and more than one abyssal species. All abyssal species that are unique to their genera naturally will have no abyssal relatives for comparison. Only six cases of multispeciation are known at present, as seen in Tables 2-6, in the genera *Ampelisca* with 3 abyssal species, *Haploops* with 5, *Hippomedon* with 7, *Harpinia* with 10, *Liljeborgia* with 3, and *Urothoe* with 4.

None of the three species of abyssal *Ampelisca* is at all closely related to the other two (see key in J. L. BARNARD 1960). *Ampelisca byblisoides* is a unique species in terms of its fifth pereopod and is unrelated to any shallow water species; *Ampelisca abyssicola* of the Caribbean is also unusual, its closest relative being the new species *A. hermosa,* described herein, which is a bathyal geminate from the Pacific side of the Panamanian Isthmus; *Ampelisca gibba* of the North Atlantic is more closely related to the sublittoral *Ampelisca brevicornis* than to any other species.

Because of their long dorsal setae and humped fourth pleonal segments, *Haploops setosa, H. vallifera* and *H. similis* form a close complex with the shallower *H. robusta* in the north Atlantic. *Haploops lodo* n. sp. from the Pacific, is closer to the Atlantic *H. robusta* than to other shallow species because of the spines on the third article of the fifth pereopod. Here is a complex of 4 abyssal species all related to the shallow water *H. robusta* but also closely related to each other. *Haploops abyssorum* stands alone, having no distinct relative.

Harpinia abyssi and *H. brevirostris,* both of the north Atlantic are more closely related to each other than to any other species. *H. abyssi* is eurybathic.

Harpinia curtipes of the abyssal north Atlantic is most closely related to its sublittoral north Atlantic relative *H. laevis.*

Harpinia amundseni is most closely related to its sublittoral neighbor *H. plumosa,* as well as to a bathyal neighbor, *H. galerus.* The direction of relationship in this complex is unknown as yet. The relationship of *H. pacifica* is unclear to the writer but it is a unique species only in an accessory head process, a probable aberration. *Harpinia excavata* of the eastern Atlantic forms a complex with two other species known from the bathyal, *H. latipes* of the north Atlantic and *H. sanpedroensis* of the eastern Pacific. Actually *H. excavata* and *H. sanpedroensis* may be paired subspecies with a parent species that was close to *H. latipes. Harpinia spaercki* Dahl, 1959 of the Banda Trench stands close to the shallow water Atlantic *H. laevis* and the shallow Galapagan *Harpiniopsis* sp. D of BARNARD (1960a). Because males have not been worked out for *H. spaercki* and *Harpiniopsis* sp. D, the precise relationships are unknown. *H. spaercki* is a species with very simple, unspecialized morphology.

The south Atlantic subspecies *Harpinia laevis capensis* J.L. Barnard (BARNARD 1961) is really closer to *H. spaercki* of the Banda Trench than to its sublittoral relative *H. laevis*, especially in the third pleonal epimeron, and certainly affirms the direction of relationship between *H. spaercki* and *H. laevis*. This is indeed an interesting situation, but as in the case of all south Pacific abyssal species, the sublittoral and bathyal relationships are poorly known because of the lack of exploration. Actually there may be a geographically closer shallow water relative of *H. spaercki* as yet undescribed.

Harpinia cinca J.L. Barnard, 1961 of the south Atlantic is related to the bathyal *H. latipes* and slightly more distantly to its abyssal neighbor, *H. excavata*. *Harpinia wandichia* J.L. Barnard, 1961 of the south Atlantic is most closely related to a bathyal eastern Pacific species, *H. profundis* J.L. Barnard, 1960a. The two species form a very closely related pair, each from a different ocean, suggesting the common distribution of an ancestor.

Relationships among the several abyssal species of *Hippomedon* are difficult to trace, because the taxonomic characteristics used to identify the species seem to be randomly assorted. Many of the species differ from two or three relatives by only one respective character, a situation which obscures relationships.

As in the genus *Hippomedon* no direction of relationship can be made for the abyssal species of *Liljeborgia*.

Urothoe elegans is an eurybathic north Atlantic species. Only *Urothoe vemae* J.L. Barnard, 1961 of the other Urothoes is even distantly related to *U. elegans* but there is no morphological evidence of a common ancestor. *Urothoe simplignathia* J.L. Barnard, 1961 forms a unique component of the genus *Urothoe* with no close relative. Although *U. rotundifrons* J.L. Barnard, 1961 is related to the Magellanic *U. falcata* and the Pacific *U. orientalis*, both shallow water species, there is no question that their affinities are quite distant.

From these opinions, the writer believes that the evidence is mounting for a strong case of regional endemism among abyssal benthic Amphipoda, and that a high percentage of the species are related closely to regional sublittoral neighbors indicating either recent population of the abyss or very slow rates of evolution and dispersion.

The age of abyssal faunas

The problem of the age of abyssal faunas has been brought into sharp focus recently by the papers of BRUUN (1956 and 1957) and MENZIES and IMBRIE (1958) as opposed to the concepts of ZENKEVITCH and BIRSTEIN (1960). On the one hand, BRUUN, MENZIES and IMBRIE give evidence and conclusions that the abyssal fauna is of late origin, that few ancient relicts are preserved in the deep sea, and that this was brought about by cooling of the deep sea in the Cenozoic. On the other hand ZENKEVITCH and BIRSTEIN dispute the evidence of paleotemperatures and show that the percentage of ancient groups is much higher in the abyss than in shallow waters, thus indicating a long, monotonous, uninterrupted history of deep cold waters with uniform environment, in which relicts and primitive groups have been preserved alive.

Both sides of the question rely heavily on evidence from paleontology, but more than a third of the species so far collected from the abyss belong to groups with little or no paleontological record and perhaps more than half of the abyssal animals will prove to belong to unfossilizing groups when more study is made of small crustaceans and tubeless worms.

As already seen the benthic abyssal amphipod fauna is largely composed of genera with diverse sublittoral representatives to which a number of abyssal species bear close relationship; none of the species in these genera is a likely candidate for relictness. There is no endemic abyssal benthic family of Amphipoda and only one endemic abyssal pelagic family, the Vitjazianidae supporting one species; this family is scarcely unique, being simply a variation on a theme interwoven among a number of closely related families.

ZENKEVITCH and BIRSTEIN point out that a mark of relictness is observable in phylogenetic groups where diversity increases with depth. The only gammaridean amphipod family to show this increase in diversity with depth is the Pardaliscidae, with 6 sublittoral and neritic species, 11 bathyal and 11 abyssal species. The family is split among pelagic and benthic species and is not necessarily primitive in any respect, since it has specialized mandibles lacking molars and some of the species are undoubtedly semiparasitic, a mark of specialization.

The abyssal uniformity theory calls for a relatively high percentage of abyssal relictness, especially with the preservation of ancient groups not now living in shallow waters. The abyssal cooling theory suggests that the abyssal fauna would have a low percentage of relicts and a high percentage of recently evolved forms with close relationship to shallow water faunas. Discounting pelagic species among the amphipods, the facts fit the supposition for a recently evolved abyssal fauna closely related to shallow water representatives, with a lack of ubiquity except among a few benthic species with special means of dispersal, a lack of evidence specially relating abyssal faunas to cold shallow seas, the lack of any markedly primitive forms in the abyss, and the very low development of endemic abyssal genera. All these facts point to some late change in abyssal environments.

The bathyal fauna

In contrast with the known benthic abyssal fauna the bathyal depths (200 to 2000 meters) reveal a number of unique and morphologically unusual amphipods, as the genus *Runanga* herein, and others such as *Uschakoviella, Byblisoides, Carangolia, Onesimoides, Actinacanthus,* and *Lepechinella.* Some of these genera have abyssal species, but primarily they are bathyal. These unusual bathyal species are only a small part of the bathyal fauna and the sublittoral remains the habitat of most of the unusual, highly specialized amphipods. One concludes that specialization decreases with depth and this would be a perfect argument in favor of preservation of relicts of unspecialized nature in the abyss, except for the fact that the unspecialized components of the abyss are clearly related to the unspecialized components of the sublittoral now living. It has been the very diverse, common, morphologically unspecialized genera of the sublittoral that have penetrated the abyss.

Because marine explorations have either concentrated in the accessible coastal sublittoral bottoms or the vast abyssal expanses, the narrow bathyal zone has not been well sampled. As a result we are unable to determine whether the percentage of unique organisms is significantly high in the bathyal. If the abyssal cooling theory is correct one may propose that some of the relict abyssal species formerly living in the warmer abyss are now preserved in bathyal depths having the same temperature regime as the old abyss. Whether we can point to some of the genera cited above as relicts of the old abyss is problematical for our knowledge of primitiveness in amphipods is poor not only because of a lack of knowledge in comparative morphology and development but the lack of a fossil record. The genera mentioned above are unique for unusual morphological features; whether these specializations are remnants of an ancient fauna can be argued from two directions. Nevertheless, the bathyal benthic fauna is richer in relict candidates than is the abyssal, but whether this can be used as evidence for abyssal cooling will depend on a future analysis of the relative percentages of unique forms in relation to the sublittoral. An unusually high percentage of unique amphipods in the bathyal would suggest that the fauna is one of relictness, with the newly evolved abyssal fauna reflecting a recently changed abyssal environment. Menzies and Imbrie (1958) reiterate the evidence that relict forms in cheilostomes and crinoids are abundant in the bathyal but not in the abyss.

Conclusions

Although the writer believes the position taken by Zenkevitch and Birstein is based on a firm foundation of knowledge and theory that the deep sea has been a relatively uniform environment for a long period of time and that there is a high percentage of relict preservation in the abyss, this concept is not easily extended into an interpretation of the present-day relationships and distribution of the Amphipoda in the deep sea. The writer disagrees with Menzies and Imbrie not so much on their conclusions but on their methods of analysis which Zenkevitch and Birstein have shown to be only partially applicable.

A part of the "uniformity" theory, whether Zenkevitch and Birstein clearly extol it or not, is that the great age of the uniform abyss permits time in which the faunas might disperse almost uniformly throughout it. This is not true of non-pelagic Amphipoda, nor of many other groups.

This brings up the question of undersea barriers and whether topography alone offers a mechanism of restriction. So far, in the study of amphipods, regional abyssal endemism appears to be the case. The present abyssal species appear more related to nearby shallow species than to cold-water shallow species and thus appear to be recent evolutes. In this re spect, one cannot dismiss the Amphipoda as a group of late origin considering the tremendous specific diversity based on a limited morphological expression, unless mutation rates in the group have been quite high. After all, the order Amphipoda comprises more than 4300 species, a number comparable to many phyla and classes. This diversity must have required a great length of time to develop.

If abyssal environments have been perpetually uniform through the geologic ages, then one must suppose that disperal rates of benthic amphipods are low and that barriers exist under which regional evolution operates; otherwise, one might consider that the abyssal fauna is quite young and composed of recent evolutes which have not had time to surmount barriers and disperse widely. If the ancient abyss had temperatures similar to the bathyal of today then present day stenothermic abyssal species are of late origin. The idea of late abyssal cooling suggests that some of the former abyssal species may have been displaced upward into the bathyal and live there today. If so, they should be subject to even greater topographical barriers than in the abyss and former ubiquitous species might now be regionally subspecific. Perhaps the species and subspecies pairs *Harpinia excavata* (eastern Atlantic) and *H. sanpedroensis* (eastern Pacific); *Ampelisca hermosa* (eastern Pacific) and *A. abyssicola* (western Atlantic) represent the results of this environmental change, but bathyal subspeciation may also be explained in the accepted way of low interregional dispersion rates and isolation, without having to resort to postulating a former ubiquitous abyssal fauna now restricted to the bathyal. To fit the present distribution and interspecific relationships of Amphipoda into the abyssal uniformity theory requires that the group be considered of late origin, with little time both to populate the abyss and form ubiquitous species. If indeed the group is ancient and the abyss has remained uniform, then some kind of dispersal and mutative stagnation occurs to prevent ubiquity and diversity into abyssal monotypes.

To fit the present status of amphipod faunas into a theory of recent abyssal cooling requires little supposition. The present day distributional patterns can be related easily to the idea of some recent change in environment of abyssal depths. Few abyssal monotypes occur; most of the abyssal species are closely related to nearby shallow water representatives; the occurrence of regional endemism indicates either a recently evolved abyssal fauna or a very strong restriction by undersea topographic barriers.

SUMMARY

1. The *Galathea* collections from depths of about 400 to 6000 meters comprise 85 species, of which 60 are new. Eight new genera are described.
2. Abyssal species number 35, including 22 new, using the depths of 2000 to 6000 meters to define abyssal. The remaining species are bathyal, from 200 to 2000 meters.
3. The continuing discovery of new amphipods indicates a relatively high diversity in the abyss and reinforces previous statements by BARNARD (1961) that regional endemism, not ubiquity, prevails in abyssal Amphipoda.
4. Most abyssal benthic amphipods belong to genera predominantly sublittoral. A total of 81 distinctly benthic abyssal species is now known; of these 46 belong to primarily sublittoral genera and another 21 belong to genera primarily bathyal. The remaining 14 species belong to genera primarily abyssal.
5. Only 6 abyssally endemic benthic amphipod genera are known. Each of these is monotypic. None displays a primitiveness.
6. No polar abyssal or polar sublittoral-bathyal species have been recovered in the abyss of low latitudes, contrary to the idea that cold polar seas provide preadapted species which spread into all abyssal regions.
7. Eleven benthic abyssal species are eurybathic. Seven of these occur in the subarctic regions.
8. No abyssally endemic highly diversified amphipod genus has been discovered.
9. Most of the abyssal species in diversified genera have close relatives in the neighbouring sublittoral and bathyal.
10. These facts point to a relatively recent origin of abyssal amphipod faunas and the suggestion is made that if the great depths of the ocean have cooled down considerably in late geologic time then previous abyssal species may have been displaced upward into the bathyal where similar ancient abyssal temperatures now prevail and that biologists should seek for relicts of abyssal faunas there. Indeed, a number of unusual monotypic genera now resides in the bathyal.

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ANIMAL LIFE FROM A SINGLE ABYSSAL TRAWLING

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INTRODUCTION

In the scientific literature on the deep-sea fauna it has rarely occurred that enumerations of the species and specimens of animals from the single localities have been made or, in other words, that an evaluation of the contents of the single trawlings has been undertaken. The only comprehensive effort along this line was accomplished by MURRAY. In his outstanding account of the results of the *Challenger* Expedition published in 1895, he listed the names and number of specimens of all species found at each of the stations worked by the *Challenger*, after the vast majority of animal groups had been worked out by specialists. In his long introduction to the report of the *Siboga* Expedition, WEBER (1902) presented much valuable information on the contents of many of the abyssal trawlings; this, unfortunately, is somewhat scattered and not easily found in his comprehensive general narrative. The following are listed as examples of later papers giving a preliminary description of the results of distinguished single hauls: NYBELIN (1951) on the trawlings of the Swedish Deep-Sea Expedition, BRUUN (1951), dealing with the work of the *Galathea* in the Philippine Trench, ZENKEVICH *et al.* (1955) on the first trawlings by the Russian *Vitjaz* in the Kurile-Kamtchatka Trench, BRUUN (1957) on the contents of a trawling by the *Galathea* in the Western Indian Ocean at a depth of 4820 m, SUYEHIRO *et al.* (1960) on Japanese trawlings in 1958, and WOLFF (1960a) on the contents of each of the known "hauls" (trawlings and bottom samples) at depths exceeding 6000 m (in the hadal zone).

It is generally accepted that animal life decreases quantitatively with increasing depth. The number of species and specimens is generally low in trawls which are brought to the surface after having worked successfully on the abyssal floor at depths exceeding some 2000 m. The contents of the three richest stations (of a total of 138 abyssal bottom trawlings and dredgings) during the *Challenger* Expedition were as follows (MURRAY 1895):

Station	Locality	Depth	No. of benthic species	No. of specimens
147	S. Indian Ocean	2925 m	87	*c.* 200
146	S. Indian Ocean	2500 m	69	*c.* 200
237	E. of Japan	3420 m	53	*c.* 150

In view of this, the results obtained from a single trawling during the *Galathea* Expedition (St. 716 at 3570 m depth in the East Pacific) were truly remarkable. It is hardly an exaggeration to say that the assemblage of animals from this station is the richest, both qualitatively and quantitatively, that has ever been collected at a single locality in the deep-sea. Qualitatively, the trawling which for the first time brought the ancient mollusc *Neopilina* to light must in itself be regarded as extraordinary, but, as shown below, several other new forms are also of more than ordinary interest. Quantitatively, it is a unique achievement *to obtain from a depth of almost 3600 m 132 different species and about 2100 specimens of benthic metazoans.* There are several reasons to account for this high benthic productivity: an area with a large primary production at the surface, excellent conditions for trawling, the fact that the *Galathea* was the first expedition to use a large trawling gear at great depths, and finally the valuable experiences gained previously – this operation being one of the last to be made during the expedition.

Last year the present author published in Danish an account of the results of this trawling (Wolff 1960b), illustrated with photographs and drawings by the artist Mr. Poul H. Winther. In view of the scarcity of such accounts and the outstanding qualities of this particular trawling, the *Galathea* Committee has found it appropriate to have the paper published in English (in a somewhat altered form) in the *Galathea Report.*

Acknowledgments

Zoologists working on taxonomy will recognize that up to the present only a rather modest number of the animals have been identified to species or described. It goes without saying that the value of this paper would have been considerably increased if all species had been worked up. It was, however, beyond the scope of the paper to effect more than preliminary identifications of the majority of the species. The following colleagues in the Copenhagen Museum have very kindly helped me with identifying certain animals or with references to literature: Kay Petersen (hydroids), Jørgen Kirkegaard (polychaetes), Elise Wesenberg-Lund (gephyreans), Jørgen Knudsen (molluscs), F. Jensenius Madsen (echinoderms), Bent Hansen (holothurians), and Jørgen Nielsen (fishes). Dr. Mathilde Schwabl (Berlin), Dr. N. S. Jones (Port Erin), Dr. Claude Lévi (Strasbourg), and Mr. Chas. E. Cutress (Washington) furnished me with preliminary identifications of the animal groups which they are working up (Solenogastres, cumaceans, sponges, and actinians, respectively). Dr. J. H. Stock (Amsterdam) advised on the walking movement of sea-spiders and Dr. J. L. Barnard (California) supplied information about various amphipods. Finally, Dr. Anton F. Bruun, the leader of the *Galathea* Expedition, read the manuscript through.

All drawings (except Figs. 10, 14, 15, and 22) were made by Mr. Poul H. Winther and most of the photographs were taken by Mr. H. V. Christensen. The English text was revised by Mrs. M. Goodfellow.

The greater majority of the blocks used for the figures have kindly been placed at our disposal by *Naturens Verden* (Munksgaard, Copenhagen), two of the remainder by *Oikos* (Munksgaard), and one by the Danish Fishery and Sea Investigations, Charlottenlund. This much appreciated help made it possible to include the many illustrations, especially those in colour.

THE TRAWLING

The *Galathea* was heading south-east along the Pacific coast of Central America. We had reached areas where wind and current cause an upwelling of nutritious water from a depth of a few hundred meters, thus giving rise to a comparatively high production at the surface as well as in the depths. Therefore, there were hopeful expectations of procuring a rich haul.

Throughout the night of the 6th of May 1952 the echo-sounder had indicated a fairly even abyssal plain with rather low, "rolling hills", lying at a depth of 3500-3600 m. It was agreed to start trawling soon after sunrise, and at 7 a. m. the huge herring otter trawl was made ready. It was of the type used by Danish fishermen. The mouth opening measured 32 m, and the length was 60 m (Pl. VII A). When in action, the mouth of the trawl was kept open by two oblique otter boards, mounted with iron and weighing 150 kg each.

At 7.15 steam was taken off one of the boilers, at 7.45 the trawl and boards were in the water, and the man at the winch began to slowly ease off wire.

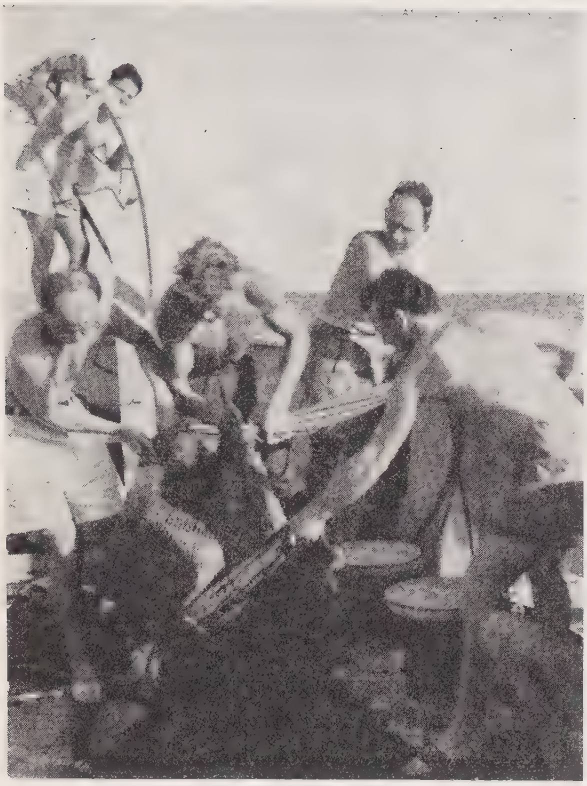

Fig. 1. The cod end of the trawl, containing the major part of the catch at St. 716, has just been lifted on board. (ALEX PETERSEN phot.).

The position was then 9°21′N, 89°12′W, the course 287° (NNW), and the screws were making 126 revolutions per minute. One and a half hours later 4000 m wire had been paid out. By 10.50 a. m. 8000 m were out. This was the length of wire which, according to our calculations, was required for the depth in question if the trawl was to move along the bottom at a rate of 2.3 knots (cf. KULLENBERG 1951, 1956).

An angle gauge was attached to the wire astern of the large trawl gallows, and a dynamometre was fixed to the wire above the quarter deck. The inclination of the wire, i. e. the angle between the wire and the surface of the water, was calculated to be 41-43°.[1] This angle would just enable the trawl to reach the bottom with the given length of wire, depth and speed along the bottom. Since the inclination was at first only 30°, the number of revolutions of the screws had to be reduced. Not until 11.45 did the angle reach 41°, and it remained there for slightly less than one hour. Consequently, we presume that the trawl was towed along the bottom for no longer than 55 minutes, although the interval between the termination of paying out the wire and the commencement of hauling was nearly three hours. The distance trawled was thus a little more than 4 km. The position during the trawling was 9°23′N, 89°32′W, lying about 425 km off the coast of Costa Rica. The direction of the trawling was 287°.

At 13.30 the hauling started. At 16.18 the boards appeared at the surface, and the winch was stopped. Another lengthy interval was required before the trawl bag was safely landed onboard, for the catch was a bulky and heavy one (Fig. 1).

Truly, it was a rich haul. All the zoologists immediately began sorting and pickling the animals obtained (Fig. 2), cleaning the meshes of the net, etc. The work lasted all that evening and the two following days. By then everything had been sorted, labelled and preserved in alcohol or formalin, except the larger fishes measuring more than one meter, which had to be stored in the deep freezer. Preliminary determinations had been made and countings recorded for the journal. Notes had been taken of colours which would eventually fade and sketches prepared, while the more remarkable finds had been photographed and filmed.

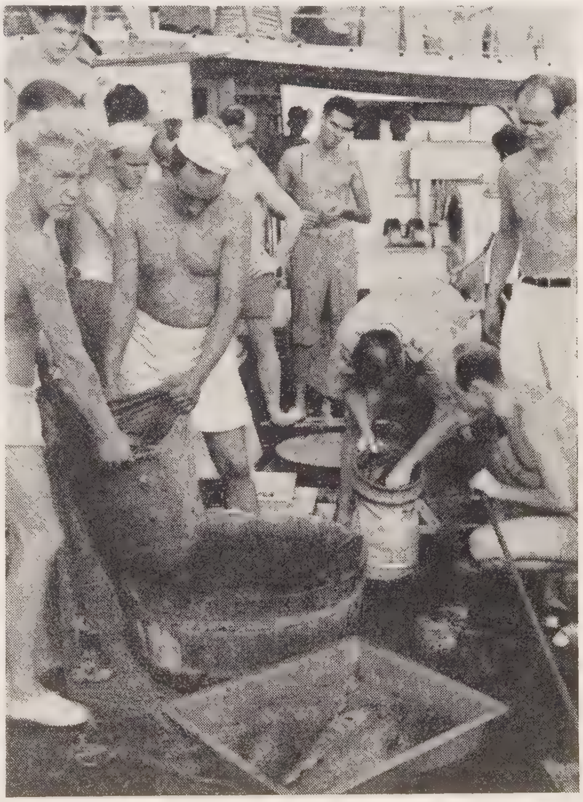

Fig. 2. The sorting has begun. In the foreground a tray with large alepocephalid fishes; behind it the canvas bag. (ALEX PETERSEN phot.).

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[1] Note the misprint in BRUUN's explanatory remarks to the List of Stations (1959, p. 21, column 2, line 4 from above): *horizontal* instead of *vertical*.

THE ENVIRONMENT

Throughout the trawling at St. 716, the echo-sounder showed a constant depth of 3570 m. The temperature at the bottom was about 1.9°, i. e. abyssal conditions. The salinity was $34.6\,^0/_{00}$, and the oxygen content as high as 2.4 ml/litre at the bottom (MENZIES *et al.* 1959). Both the *Galathea* and the *Vema* (see below and p. 135) found the bottom sediments to be a dark greenish, somewhat clayey ooze with many remains of diatoms, radiolarians, and pelagic foraminifers. The *Vema* also found a geologically-recent (Pleistocene) layer of ash covering much of the area (l. c.). This was 2-15 cm thick and of variable depth in the sediment. An ash-fall as extensive as this must have had a marked effect on the fauna even at abyssal depths. The same applies to the strong decrease of temperature which took place in the deep-sea at the onset of the Glacial Age. Thus, an ancient animal like *Neopilina* (see p. 136) was not "just" able to survive to the present time in the constant natural conditions hitherto believed to prevail in the deep-seas. Here, too, upheavals take place that may prove fatal to existing life.

THE ANIMAL ASSEMBLAGE ON PLATE IX

In some of the illustrations it has been endeavoured to show a few of the animals from St. 716 in their natural environment. On the large drawing (Pl. IX) some of the most striking creatures have been especially selected for demonstration. It should be pointed out that depicting this great concentration of animals in one spot was considered necessary for economic reasons, the aim being to show as many locally occurring species as possible. An assemblage of animals to the extent shown would be difficult to envisage – even in this abundant locality. Theoretically – very theoretically – there is, however, a possibility for a "snapshot" like this, since all the animals were actually collected in the same locality.

Neopilina

In spite of their modest size and unimpressive appearance the two cap-shaped molluscs in the middle of the plate are, without doubt, the most interesting – and the most famous. The animal was described by LEMCHE in 1957 under the name *Neopilina galatheae*, as a living representative of the Cambro-Devonian class Monoplacophora. The material comprised ten specimens with soft parts (Fig. 3) and three empty shells, the largest of the former being 37 mm long, 35 mm broad and 13 mm high. A mature male and female were cut in sections and their anatomy described in a large, abundantly illustrated monograph (LEMCHE & WINGSTRAND 1959). The fine structure of the shell was studied by SCHMIDT (1959).

The bearing of *Neopilina* on the systematics of the molluscs was touched upon by LEMCHE & WINGSTRAND (l. c.). In addition, several preliminary phylogenetical considerations have been published by LEMCHE (1959a, 1959b, 1959c, 1960). He has, i. a., thought it possible to homologize the primitive comb-like gill (ctenidium) with the legs of arthropods, to show that the ventral position of the mouth in *Neopilina* and Polyplacophora (chitons) is similar to that found in trilobites, *Limulus*, primitive crustaceans and polychaete larvae, and to demonstrate that the muscle arrangement points towards a direct derivation of molluscs from coelenterates.

The remarkable find of *Neopilina* provided incentive for two American and one Russian research vessel to investigate the type locality of *Neopilina* off Costa Rica in order to procure more material. Only the Lamont Geological Observatory ship (the *Vema*) in 1958, during the course of 11 hauls in the area (with a 1 m dredge – cf. p. 156), found one small specimen at a depth of 3720 m (MENZIES *et al.* 1959).[1]

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[1] Based on the known mouth opening of the trawl or dredge used on the *Vema* and (probably) the period the trawl remained on the bottom, MENZIES *et al.* (l. c., p. 175) state that each of the eleven *Vema* hauls in the Costa Rican area covered "an estimated average area of 2000 square meters. This suggests [citation continued] that the animals, if randomly dispersed, occur in the abundance of one for each 22.000 square meters. Doubtless they are not randomly dispersed as was indicated from the "GALATHEA" capture of 10 specimens from one 55 min. cast of the herring otter trawl; however, the average population density must be exceedingly low. The trench monoplacophorans [*N. (V.) ewingi*] show a significantly higher population density, namely 0.7 for each 1000 square meters or more than 15 times that of *Neopilina* (sens. str.)." The authors also tabulate the density of each of the other animal groups collected in the Costa Rican area and in the Peru-Chile Trench (Tables 1 and 2).

This is certainly the first time that density has been estimated in this way. It seems premature to do so, unless the authors can satisfactorily explain, a) how the precise moment the trawl reaches the bottom can be determined with this small type of gear (according to our experience this

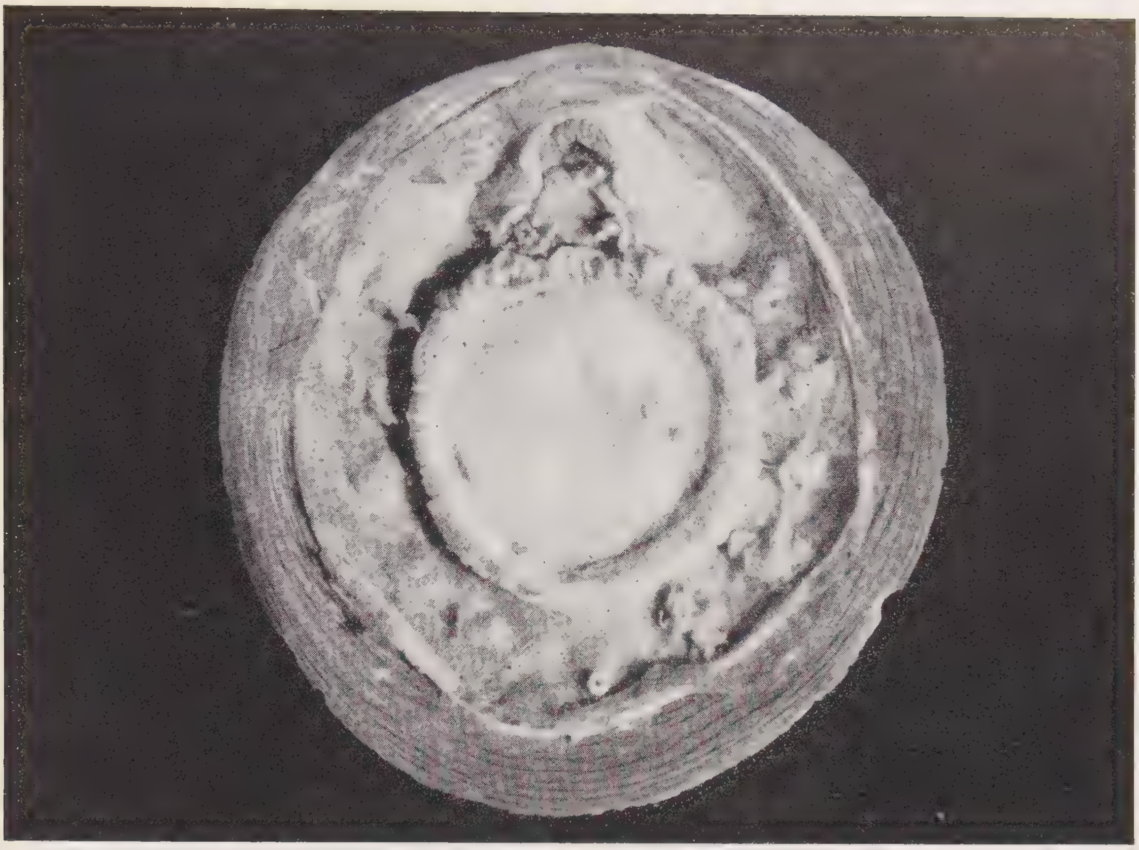

Fig. 3. Ventral view of *Neopilina galatheae.* On the outside, the continuous pallial fold has been detached from the shell margin as a result of preservation. Anteriorly is the mouth, surrounded by the lips, velum and oral tentacles (homologous with lips and labial palps in bivalves, and the postoral tentacles homologous with the arms in cephalopods). The foot is in the centre, the anus posterior. The metamerism is shown exteriorly by the five pairs of gills, interiorly by ten pairs of nerve connectives, eight pairs of large pedal retractor muscles, six pairs of nephridia, two pairs of gonads, and two pairs of atria.
(M. Øye phot.).

Later, the Scripps Institution of Oceanography vessel, the *Spencer F. Baird,* collected three more specimens 3000 km further north, off the tip of the southern end of Baja California during the Vermillion Sea Expedition at a depth of 2780-2810 m. A shell fragment was also taken in a Petersen Grab at a depth of 1830 m in a locality just north of the first sample (Parker, in press). Very recently an Allan Hancock Expedition found 14 very small specimens of a *Neopilina* (1.3-2.4 mm) at 2730-2770 m depth somewhat north of the two latter finds. This is perhaps a third species, having six pairs of gills (like *ewingi* – see below), but differing in shell structure from this species as well as from *galatheae* (Menzies & Robinson 1961).

After the meagre results off Costa Rica in 1958 – as far as *Neopilina* is concerned – the *Vema* continued southwards. Off Peru, at four localities in the upper part of the Peru-Chile Trench (5610-6320 m), the expedition succeeded in obtaining a total of ten specimens of another *Neopilina,* which was described as a new species and subgenus, *Neopilina (Vema) ewingi* (Clarke & Menzies 1959).

Neopilina galatheae has six pairs of nephridia but only five pairs of gills (Fig. 3). The five posterior pairs of nephridia open at the base of the gills while

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happens long after one has stopped paying out wire; b) the exact speed at which the trawl moves along the bottom (the speed at the surface is likely to differ greatly). Only when Kullenberg's calculations for larger trawls (1951) are applied is it possible to provide a rough idea of the said factors in deep-sea trawling (cf. p. 131). The metering devices, designed by R. Bieri and J. Bradshaw (Gunter 1957, Fig. 10) and by R. Riedl (1955, Figs. 1 and 5), or the so-called trawlograph which has been used by Russian oceanographers on sledge (Agassiz) trawls (Zenkevich 1956, Fig. 12, Zenkevich *et al.* 1959, Fig. 2, and Fig. 4 in this paper), seem to be better methods than that based on Kullenberg's calculations to obtain comparatively reliable data on the area covered during the actual trawling on the bottom.

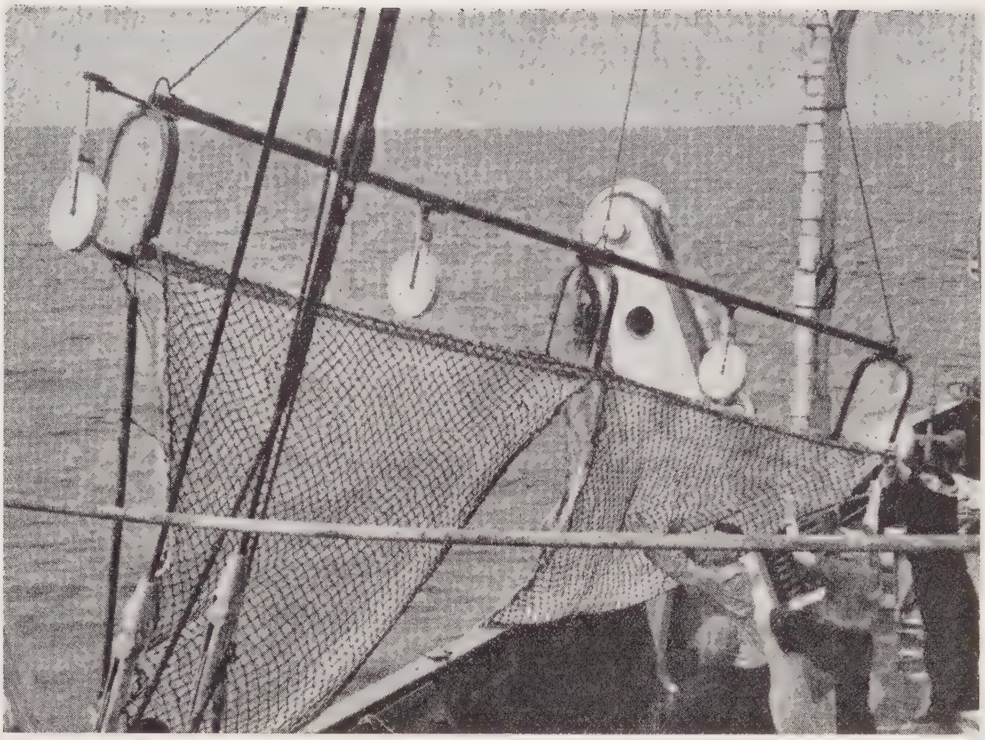

Fig. 4. A 6 m sledge (Agassiz) trawl onboard the Soviet research vessel *Vitjaz*. The trawl is of the same type as that constructed earlier on the *Galathea*. It is furnished with four trawlographs, each consisting of a metal disc with small projections on the edge. The disc rolls along the bottom and a computing apparatus measures the distance trawled. The photograph was kindly placed at my disposal by the Oceanological Institute, Moscow.
(V. Nartsissova phot.).

the renopores of the anterior pair are found in the pallial groove well anterior to the first gill. Thus, a pair of gills was apparently "missing". However, in *N.* (*V.*) *ewingi* a sixth pair of gills is found in connexion with the first nephridia (l. c.).

Menzies *et al.* (1959) published photographs of the Peru-Chile Trench floor. Fig. 8 C (misprint for 8 D) and Fig. 9 of that paper show what is claimed to be tracks made by two *Neopilina ewingi*. With the authors' kind permission the original photographs are shown here (Pl. VIII A and B). At the extreme end of the right track is a rather high, compressed object (note its shadow to the right) and behind it (on the other side of the crossing track) is a somewhat similar object, less distinct, but also casting a shadow. In my opinion neither of these two objects can be identified as the upper part of a *Neopilina* shell as the authors claim. This would appear as a much lower, vaulted "knoll" – cf. Fig. 1 C in Clarke & Menzies (1959) and in this paper Fig. D (Pl.VIII) of *N. (V.) ewingi* and Fig. E of *N. galatheae*.

It seems more likely that the picture shows a bivalve ploughing its way through the ooze in the same manner as e. g. *Montacuta ferruginosa* (personal observations). The tracks are clearly V-shaped and have thus been formed by a compressed, sharp-edged animal. The track left by a *Neopilina* would be broader and more open. This is extremely evident when the groove-shaped track left by the bivalve *Cardium* on the soft surface of the wadden sea is compared to the very broad and shallow tracks of the gastropod *Littorina* (Thamdrup 1935, Figs. 120 and 124). Moreover, the visible part of the *Cardium* at the end of the former track (Fig. 120 and Fig. C (Pl.VIII) in this paper) closely resembles the object at the end of the right track in Figs. A and B (Pl.VIII). Finally, the assumption that a bivalve and not *Neopilina* is the animal in question is supported by the fact that while the *Vema* collected only 3 specimens of *Neopilina* at this station (150) it took 56 specimens of bivalves. In the total area only 10 *Neopilina* but no less than 733 bivalves were collected. This would provide a much greater possibility for photographing a moving bivalve, although it is true that some of them may – during their entire lifetime or most of it – remain completely buried in the ooze.

There are apparently two animals at the end of the right track. However, the posterior (lower) object is probably not an animal at all but a small mound which the animal passed close by before reaching the extreme end of the track. A similar, although less high, object can be seen on Figs. A and B, lying close to the track about 20-25 mm behind (under) the first one. The latter object is almost certainly a small mound.[1]

MENZIES *et al.* did not discuss the strange fact that the left track ends blindly. In my opinion the only explanation seems to be that the animal buried itself into the ooze (or, less probable, emerged from it). It is, however, rather remarkable that no trace of a hole or any disturbance of the ooze appears to have been left.

Finally, it is evident that the left track has crossed the right and, consequently, is the most recent. This is surprising in view of the fact that the animal at the end of the right track is so close to it. Again the only possible explanation is presumably, that the visible animal was stationary while another animal, which made the left track, emerged from the bottom, moved behind the first animal and disappeared beyond the range of view before the photograph was taken.[2]

However all this may be, it is very probable that *Neopilina* actually *does* creep along the bottom, as also shown on Pl. IX. On the anterior part of the shell of one *N. galatheae* small hydroids have been found (possibly *Perigonimus)* which prove that the animal, at most, lives partly buried, but the fact that the foot is only feebly musculous makes it doubtful whether it moves around very much. It is obviously a deposit feeder. All the intestines were filled with material similar in appearance to the bottom ooze adhering to the outer surfaces. According to LEMCHE & WINGSTRAND (1959) this material "includes a high proportion of radiolarians, scattered centric diatoms, etc., mixed up with much undefined detritus matter" (Fig. 5). Similarly, a faecal pellet of *N. (V.) ewingi* contained "diatom frustules, radiolarian skeletons, pelagic foraminiferal tests and innumerable bacteria-size particles as well as sponge spicules" (MENZIES *et al.* 1959). It seems probable that both the velum and postoral tentacles (Fig. 3) serve as food-collecting organs.

In the current discussion on the antiquity of the deep-sea fauna, MENZIES & IMBRIE (1958) stated *Neopilina* to be the only Palaeozoic relict known in the abyssal fauna, while ZENKEVICH & BIRSTEIN (1960) listed it, in conjunction with several others, as an ancient element of the deep-sea. MADSEN (1961 b) pointed out that much of the difference of opinion is due to the fact that the two latter authors have attributed animals found below a depth of about 600 m to the abyssal fauna, thereby including not only the abyssal but also most of the bathyal fauna. It is generally accepted that the bathyal region contains a considerably larger number of ancient (i.e. at latest Early Tertiary) species than the truly abyssal region (at depths exceeding about 3000 m). The recent find of *Neopilina* also at bathyal depths (cf. above) may therefore indicate that the Monoplacophora thrived at bathyal rather than at abyssal depths for the greater part of their evolution. This suggestion is in agreement with MADSEN'S (1961 b, p. 191) who wrote that "the group may have been already represented in the abyssal deep-sea in the Early Palaeozoic, but it is also conceivable that, when during Devonian times it disappeared from the fossil record, it was still confined to moderate depths, and not until a much later geological period extended its range also to the abyssal zone". Although not generally accepted, there is much evidence of a radical change in temperature and other physical and chemical conditions in the abyssal region towards the end of the Tertiary (cf. MADSEN (1. c., p. 187) and MENZIES *et al.* 1961). It appears more likely that *Neopilina* did not descend into abyssal depths until after such changes had taken place, than, alternatively, that it was able to survive there in the period during which these changes occurred.

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[1] According to MENZIES *et al.* (1. c., p. 178) their submarine photographs covered an area roughly equal to 200 sq. m. in the Peru-Chile Trench locality. Based on the assumption that the two objects under discussion are *Neopilina*, the authors venture to suggest an, admittedly "very rough", estimate of a density of two *Neopilina* per each 200 sq. m. and to compare this density to that derived from the trawl catch, the latter representing "around 25 times less density than the photographic density on the bottom". A density estimate derived from such submarine photographs appears to be still more premature to undertake than the above mentioned estimates based on the results of the dredgings.

[2] Another of the animals on the photograph (Pl. VIII A) was identified by MENZIES *et al.* as a "holothurian in upper right corner". This must be a misprint for *left* corner since the undeterminable object in the right corner is definitely not a holothurian. The many small vertical sticks were termed "worm tubes". These are possibly sea-pens (aff. *Virgularia)*, being certainly too long and stiff for most worm tubes. Two of them have seemingly been lifted up by the holothurian in the upper left corner. They are too long and narrow to be interpreted as papillae of a *Scotoplanes* (cf. Pl. XB).

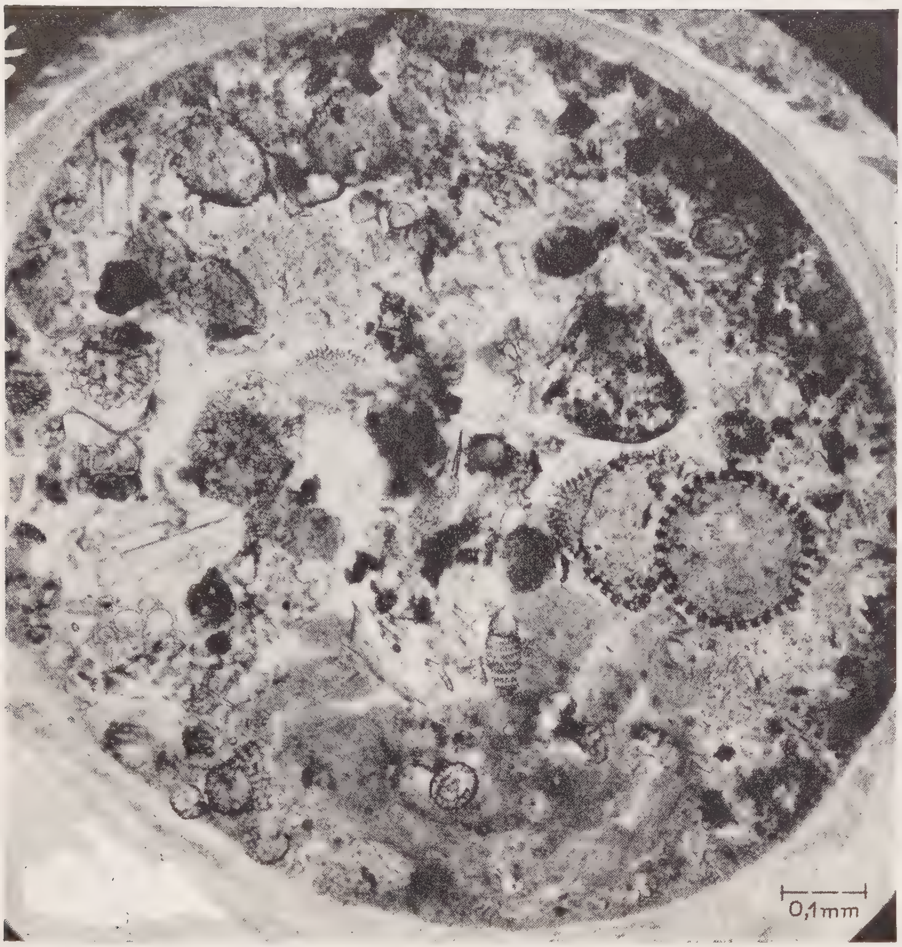

Fig. 5. Cross section through the first intestinal coil of *Neopilina galatheae*. Radiolarians are abundant. (After LEMCHE & WINGSTRAND 1959).

Probeebei mirabilis

The orange coloured crustacean on Pl. IX also proved to be of great interest. It is a well-known fact that the hermit crab normally hides its soft abdomen in a gastropod shell which it carries around with it. Owing to this spirally-coiled accomodation, the abdomen has in the course of time attained a wry and asymmetrical shape; the claws have become unequal in size, and certain abdominal legs (pleopods) formerly situated on the right side have completely disappeared. This asymmetry is so genotypically fixed that it inevitably appears in the first postlarval stage independent of whether the snail shell is occupied or not. However, a small, separate family, the Polychelidae – consisting of primarily bathyal species – has preserved the original symmetry of hermit crabs, all abdominal legs are present on both sides, and the abdomen is as symmetrical and armoured as that of a common or of a spiny lobster.

In almost all respects the reddish crustacean from St. 716 is a typical hermit crab: the 2nd and 3rd pairs of walking legs are long and the 4th and 5th pairs much shorter and of a different shape, the abdomen is asymmetrical, and the abdominal legs absent on the right side. The segments of the abdomen are, however, as hard and calcified as in the Polychelidae. This is, consequently, a species whose ancestors have gone through the entire evolution from the original, symmetrical form, which was freely-roaming, via the stage in gastropod shells where the asymmetrical abdomen, etc. was eventually developed, and finally back to a free mode of life where the abdomen is protected by its own armour but the asymmetry preserved. Only one instance of a similar evolution is known, the robber crab, *Birgus latro* which lives on dry land. In both cases this secondary calcification of the abdomen must be due to lack of sufficient shell material.

Only one post-larva of this remarkable crustacean has been known previously. It was collected by the American *Arcturus* Expedition at a depth of 1145 m West of the Gulf of Panama and described under the name of *Probeebei mirabilis* by BOONE (1926) who regarded it as a primitive macruran. St. 716 yielded

18 specimens, including adults and several developmental stages. A description of the species and its bearing on phylogeny and evolution has recently been given (WOLFF 1961 a, 1961 b).

The body length of the ovigerous female on the plate is 6.5 cm, when measured with the abdomen bent under the body. Situated on the carapace and legs are several small white tubes of a serpulid polychaete worm.

Probeebei is perhaps the most recent and the most highly specialized hermit crab, thereby forming a strong contrast to *Neopilina.* The ancestors of the latter may be traced further back than those of probably any other existing animal. It has remained almost unaltered during the vast span of 350-400 million years.

Neotanais pfaffi

The two chalk white crustaceans in the left bottom corner of Pl. IX are a female and male of tanaids, a group closely related to the isopods. They are *c.* 20 mm long and were referred to a new species, *Neotanais pfaffi* (WOLFF 1956a). At St. 716 a total of 41 individuals was collected. *Neotanais* belongs – together with another genus of exclusively hadal occurrence – to a separate, apparently rather primitive family within the tanaids. Apart from a single find in the North Atlantic at about 700 m and at a temperature of some 10° C. (incidentally, a find which is not too reliable) none of the 13 species of this family have ever been taken at depths of less than 2000 m or at temperatures above 3.3° C., and two of the species are even hadal. This is enough to show that Neotanaidae is one of the very few pronounced deep-sea and cold-water families of the animal kingdom (WOLFF 1956c).

Galatheathauma axeli

The large fish *Galatheathauma axeli,* to the left in Pl. IX, is without doubt the strangest fish taken by the expedition. It obviously belongs to the Pediculati or angler fish, but in length (47 cm) it exceeds almost all other members of the order. The light organ is forked and hangs down like a clapper from the palate *inside* the mouth. The latter is enormous in size and furnished with a terrifying row of long and pointed, slightly curved teeth. There are also smaller teeth around the entrance to the pharynx. The mouth works like a trap when the prey (probably fish, crustaceans, etc.) is lured too close to it – possibly attracted by the light organ. The eyes are minute and vestigial and are situated close to the corners of the mouth.

There are two factors which seem to indicate that *Galatheathauma* lives close to the bottom, unlike almost all other deep-sea angler fish; in the first place it has never been caught pelagically – not even during the very extensive work by the *Dana* Expedition close to this area. Secondly, the mouth is directed downwards which indicates that it attacks from above – unlike the great majority of pelagic Pediculati in which the mouth is directed upwards. However, not until more specimens become available and their stomach contents investigated will the question of the habitat of this unique fish be finally settled.

Bassogigas and the alepocephalid fish

The uppermost of the two fishes (top right) is probably a *Bassogigas digitatus.* It has been taken on four previous occasions, each time in the Eastern Pacific and always at depths between 2200 and 3440 m. Eight specimens were caught at St. 716, three of which may, however, belong to a different species. The specimen shown measures 28 cm, and the beautiful steel grey colour of its head is still preserved. The genus *Bassogigas* contains eight species (GREY 1956) which are all abyssal (1800-4600 m). One of its representatives may descend to the upper part of the hadal zone, the deepest-living fish caught by the *Galathea* being a *Bassogigas* from 7160 m in the Sunda Trench south of Java.

The other fish belongs to the family Alepocephalidae which consists of fairly large deep-sea fishes, in a total of 17 genera with 40 species. Some of these are no doubt pelagic, but others have been taken in bottom trawls only. This fact, as well as certain features in their shape make it highly probable that they are benthic. On the other hand, it is very likely that now and again they may swim away from the bottom – in e. g. a manner similar to that of the cod. St. 716 yielded a total of four giant alepocephalids, 50-66 cm long, with large, broad heads and bulky bodies and with muscles of a rather gelatinous consistency (Figs. 2 and 26). There are two species, one probably belonging to *Bathytroctes*, of which six, exclusively abyssal species are known (GREY 1956).

Hyalonema and Epizoanthus

To the right and immediately in front of this fish are to be seen two stalked siliceous sponges belonging to the genus *Hyalonema*, which is probably the most common sponge at bathyal and abyssal depths. It contains 95 species which have been referred to 14 subgenera. The present species is *H. bianchoratum* which was previously taken twice – off West Mexico at a depth of 3437 m and off North Peru at 4063 m (Wilson 1904).

The "body" of this species is roundish, of a cotton-like consistency and with distinct openings (oscula) for the outstreaming water. As in other siliceous sponges the spicules are infinitesimal although the long stalk is very conspicuous. It consists of fine, parallel or slightly coiled, siliceous threads, up to 1 m long which are transparent and as sharp as glass splinters.

On several of the stalks abundant growths of colonies of the sea-anemone *Epizoanthus* are present. Such colonies are also frequently seen covering gastropod shells inhabited by deep-sea hermit crabs. These *Hyalonema* stalks often serve as an excellent base for hydroids, the stalked barnacle *Scalpellum* and other sedentary animals which are able, in this way, to raise themselves above the soft bottom.

Umbellula thomsoni

Finally, Pl. IX shows a few pink, flower-like organisms whose fine branches are stirred by the faint bottom current. These are a special kind of sea-pens, almost certainly the species *Umbellula thomsoni*. The colonies are about 15 cm high and the numerous single individuals (polyps) can be distinguished on the arms. All the colonies of this species and of the two other species from St. 716 (see p. 142) are young ones. This is probably due to the fact that the older colonies, which may reach a length of 2 m, are so firmly planted in the sea bottom that they will bend, but can not be torn away when the trawl passes over them. It is also known that, when alarmed, shallow-water forms may contract violently, whereby all the soft parts suddenly disappear beneath the bottom and only the "empty" stalks remain, thus leaving very little for the trawl to grip. *Umbellula thomsoni* has frequently been taken in the Atlantic, the Indian, and the Western Pacific Oceans (at depths between 1000 and 5850 m), but not until now in the East Pacific.

The genus *Umbellula* was revised by Broch (1958) who recognized only seven valid species ranging in depth from 77 m (in the Antarctic) to 5860 m.

DEEP-SEA ANIMALS ON STILTS

On Pl. X are grouped together two strange, long-legged forms. A considerable prolongation of legs and sense organs (in crustaceans, especially the antennae) is one of the most characteristic features of deep-sea animals. The stilt-shaped legs have presumably become developed to adapt to the soft bottom, while the prolongation of the antennae is doubtless a result of eternal darkness and consequent blindness.

Colossendeis colossea

Fig. A shows an orange coloured sea-spider or pycnogonid. The *Galathea* collection of this extraordinary group was worked up by Louis Fage (1956a, 1956b) who referred this individual to the species *Colossendeis colossea,* i. e. "the gigantic giant". It is indeed a giant among sea-spiders, the majority of which grow no bigger than the size of a normal hand (many being much smaller). This particular specimen measures more than half a meter from the tip of one of its walking legs to the far end of the opposite leg.

The sea-spiders form a group which is fairly poor in species and their systematic position within the Arthropoda is still uncertain. The legs are almost always greatly prolonged and are attached to a body ridiculously minute in comparison. Therefore, there appears to be reason enough for the intestine sending blind sacs far out into the legs. The abdomen is reduced to a very small tap. A long proboscis is present on the head and is extremely mobile at the base. Interiorly, it is provided with teeth and a complicated sieving apparatus which rejects coarser particles. The long-legged forms always have a greatly prolonged proboscis – perhaps analogous with the long neck of the giraffe. In front of the four pairs of walking legs, which are of equal length, this species has a pair of palps which – at least in littoral species – are used for seizing and holding the prey. Next is a pair of so-called ovigers on which the male carries the eggs in a ball-shaped lump. On the inner side of their distal segments these legs are provided with comb-shaped spines whose function it is to clean and rid the other legs of mud, etc.; this is performed by movements from the proximal towards the distal end of the legs, as shown in the drawing.

Certain difficulties were encountered in reproducing the exact manner in which the animal walks along the bottom. PRELL (1910) and HELFER & SCHLOTTKE (1935) have published descriptions of the slowly advancing walk and swimming movements of closely related forms. On the basis of these descriptions and advice given by the Dutch specialist Dr. J. H. STOCK, we have tried to reconstruct the animal's walk. Actually, this corresponds closely to the method of swimming – in slow-motion. The articulations of the legs are built in such a way that the legs themselves can only move in the vertical plane. Furthermore, the pycnogonids do not walk on the tips of their claws but keep them rather somewhat bent towards the direction of the following joint.

An excellent photo (from a depth of 1800 m) of a large *Colossendeis,* measuring 70 cm, was published by OWEN (1958).

With regard to food, littoral forms show a preference for hydroids and sea-anemones. On almost all occasions the Norwegian *Michael Sars* Expedition collected hydroids together with sea-spiders in the same deep-sea trawling, and frequently also antipatharian corals, sea-pens and sea-anemones (MURRAY & HJORT 1912). This may indicate that sea-spiders share the same choice of food in the deep-sea and that "our" *Colossendeis* could fill all of its many blind sacs by sucking on the hydroids and antipatharians, mentioned on p. 141, or the sea-pens and sea-anemones, shown on pl. IX.

Colossendeis colossea is an example of the rather few deep-sea species among the sea-spiders which are known from all oceans except the high-arctic ones. Like a considerable number of other species of sea-spiders it has a wide vertical distribution (from 865-4140 m). It is, however, limited to bathyal and abyssal depths, as are nearly all the other species of the genus.

Limopsis compressus and Stephanoscyphus simplex

The partly buried bivalve (Pl. X A) is *Limopsis compressus* which is about 4 cm long. It was originally taken by the *Albatross* in 1891 at eight localities in the Gulf of Panama, at depths between 1950 and 4100 m (DALL 1908)[1] and not seen again until the *Galathea* collected numerous specimens in the same area – e. g. at St. 716 twenty individuals. *Limopsis* is primarily a deep-sea genus which includes almost a score of species, all with the outer horny layer (the periostracum) prolonged into a hair-like fringe along the edge of the shell. The possible function of this fringe is unknown.

Attached to the shell of *Limopsis compressus* are some old tubes of the same species of serpulid worms as those which have settled on the hermit crab (p. 137). On the right side of the shell is a single tube of the polyp *Stephanoscyphus simplex*. This tube is unbranched, measures up to 2 cm in length, is ringed and fairly soft, and has interior thickenings. At the base there is a small disc. KRAMP (1959) worked up the large *Galathea* collection of this species from a total of 29 localities. This is an impressive number, considering that the species was only recorded from eight other localities by all previous deep-sea expeditions. It is distributed in all three world oceans at depths between 450-7000 m. By far the majority of the finds are abyssal, and consequently, from areas with temperatures below 4° C. The few localities (e. g. off the Philippines) where it occurs at temperatures up to about 10° C. all seem to be characterized by a very rich fauna. It is very likely that the abundance of food is a strong factor in making it possible for a primarily abyssal species like *Stephanoscyphus* to thrive here; the higher concentration of food thus compensates for the increase in metabolism which is a consequence of the higher temperature.

The actual type of medusa produced from this polyp is still in some doubt. KRAMP (l. c.) found very young medusae in the tube of one individual which can, with some hesitation, be referred to the genus *Nausithoë*. It is known that this genus represents the medusa of one or two other species of *Stephanoscyphus*. Three bathypelagic species of *Nausithoë* exist, and some time in the future one of them will certainly prove to be the sexual generation of the asexual polyp *Stephanoscyphus simplex*.

Munnopsis longiremis

The two crustaceans on Fig. B. (Pl. X) are isopods, belonging to the species *Munnopsis longiremis*. Of this species only one specimen has previously been taken (at a depth of 1485 m off the Galapagos Islands by the *Albatross)*, whereas we obtained 37 individuals at St. 716. *Munnopsis longiremis* belongs to a family with two genera, one of which has three purely pelagic species, while all ten species of the other genus appear to be bottom forms (WOLFF, in press). The species are i. a. characterized by their enormously prolonged antennae and 3rd and 4th pairs of legs. The body length is less than 20 mm.

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[1] The American *Albatross* is the only other research vessel which worked in the deep-sea of this area prior to the *Galathea;* most of its work took place around the turn of the century.

A study of the intestines of seven specimens of *M. longiremis* from St. 716 – and of several other *Galathea* isopods – has shown that the deep-sea forms are primarily deposit feeders, utilizing the organic matters in the bottom sediments. In all seven specimens of *longiremis* I found many diatoms, radiolarians and sponge spicules, a few polychaete bristles in some, and several shells of pelagic foraminifers in another. They are probably also occasional predators or scavengers, since one contained fragments of an asellote isopod and another, fragments of a benthic copepod.

The movements of these animals are very interesting and were studied on a Nordic species, *M. typica*, by SARS (1899) and HULT (1941). Since *typica* is a closely related species with a virtually identical shape, I have ventured to assume that the same characteristics are true of *longiremis*. The walking movement is slow and tottering and may be taken in all directions, forwards, backwards or sideways. Now and then the animal stops to pick up small particles from the bottom, using the first and, in particular, the second pair of walking legs. The particles are brought to the mouth, but apparently no actual feeding takes place in this way. If the animal is disturbed in some way or other the body is pressed close to the bottom. But if seriously alarmed, the oar-shaped posterior legs (5th-7th pairs) make violent, simultaneous strokes, causing the animal to dart backwards and upwards, away from the bottom. Meanwhile the antennae and the four elongated legs remain close together and are drawn after the body (as illustrated by the swimming animal which, accordingly, is moving towards the left in Fig. B). When the animal ceases to swim the antennae and legs are spread apart, and like a parachute it sinks again towards the bottom, in much the same manner as a swimming sea-spider. It is not unlikely that it will land upside down, but a forward or a backward somersault turns it around again – successfully preventing its long appendages from becoming entangled.

Scotoplanes n. sp.

The animal in the foreground of Fig. B is a representative of the most abundant deep-sea group of animals – at least as far as weight is concerned, i. e. the sea-cucumbers or holothurians, relatives of the starfish, brittle-stars and sea-urchins. The present species is identical with one taken by the *Albatross* at two localities off Peru (at 4050 and 5200 m depth). CLARK (1920) referred the *Albatross* specimens to *Scotoplanes murrayi*, collected by the *Challenger* in the Antarctic Indian Ocean (2300 m). In his monograph on the *Galathea* holothurians BENT HANSEN has, however, the intention of describing the Pacific form as a new species. The *Challenger* collected one specimen, the *Albatross* four, and the *Galathea* fifty-four. *Scotoplanes* is a pronounced deep-sea genus, even counting two hadal species, one in the Kermadec Trench (6180-6770 m) and one in the Philippine Trench (9820-10.000 m), so far the deepest record for identified species of holothurians (B. HANSEN 1956).

The holothurian is here drawn visibly on the bottom, not buried in the ooze. This was done purposely owing to the existence of a deep-sea photograph (LAUGHTON 1959, Fig. 11), showing a species of the closely related genus *Peniagone* crawling free of the bottom.

This species of *Scotoplanes* may vary in size from 2 to 8 cm. The mouth is surrounded by a ring of tentacles which help to collect the bottom sediments, the sea-cucumbers being typical mud-swallowers. As well as a double row of tube feet there are four long papillae on the dorsal side. The skin contains a large number of minute spicules, and as in most other deep-sea holothurians, it is very delicate and transparent.

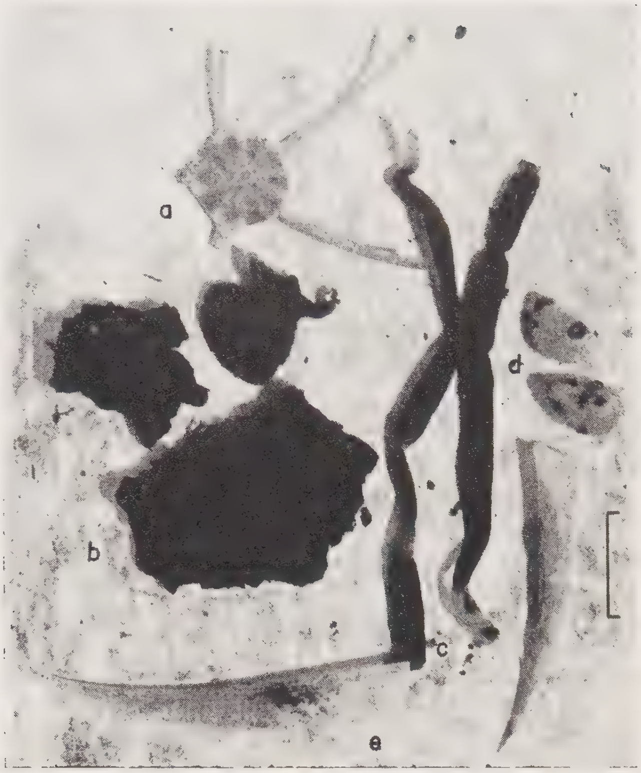
THE REMAINING ANIMALS

Sponges

In addition to the *Hyalonema* shown on Pl. IX, St. 716 yielded two other species of this abundant genus. One is, according to Dr. CLAUDE LÉVI, a new species of the genus *Asbestopluma* which has a bipolar and abyssal distribution. The sponge is globular in shape and raised from the bottom by means of a stalk. The other is the second known record of *Cladorhiza linearis* which was first taken by the *Challenger* in 1875 at a depth of 4362 m in the Central South Pacific (RIDLEY & DENDY 1887).

Although the protozoans from St. 716 are not

Fig. 6. Various animals from *Vema* stations off Costa Rica. a, an ophiolepid, probably either *Ophiura irrorata* or *Ophiosphalma glabrum;* b, the large, flat foraminifer *Stannophyllum zonarium*; c, tubes of a maldanid polychaete; d, the holothurian *Sphaerothuria bitentaculata;* e, the scaphopod *Dentalium megathyris*. The identifications are made by comparing them with specimens from the *Galathea* trawling. The scale is 2 cm long.
(After MENZIES *et al.* 1959).



under consideration in this paper, there are worthwhile reasons for mentioning one foraminifer which occurred at this locality in large quantities. Its shape is flat and mat-like, the consistency much like that of felt and the colour very dark green. It is badly broken but there are specimens as large as 10-15 cm. It was preliminarily referred to the sponges in Copenhagen and sent to Professor LÉVI with the sponge collection. The *Vema* also obtained specimens in this area and likewise regarded them as sponges (MENZIES *et al.* 1959); some fragments are shown on Fig. 6 b.

This peculiar group was first described by HAECKEL (1889) who worked on the *Challenger* material. He established no less than 26 very arbitrary "species" and 11 "genera" which he referred to the horn sponges (Keratosa). GOËS (1892) studied material from the *Albatross* and found the animals to be Foraminifera. GOËS' species was later shown to be identical with HAECKEL's *Stannophyllum zonarium* and according to Dr. AKSEL NØRVANG of the Copenhagen Museum, the *Galathea* specimens may also belong to this species. It is probable that HAECKEL's eight species of the two genera *Psammophyllum* and *Stannophyllum* can all be referred to *S. zonarium* which has thus a wide distribution (Pacific and Indian Oceans) and occurs only at depths between 3000 and 5300 m.

Coelenterates

Some of the coelenterates were mentioned above, namely the scyphozoan *Stephanoscyphus* (p. 139) and the hydroid on the *Neopilina* shell; this hydroid also occurred on some of the sea-stars from this station (see p. 152). In addition, there were three small colonies of a *Sertularia* species, only a few cm high, on which a few individuals of the genera *Lafoea* and *Campanularia* were growing. More conspicuous are eight beautifully feathered colonies of an antipatharian coral of the genus *Bathypathes,* each about 25 cm high. The stem of the colony is attached to a worm tube, and the numerous single polyps are situated in ranks along the fine, dark brown branches.

In addition to the zoantharians on the *Hyalonema* stalks (see p. 138), seven species of actiniarians were taken at St. 716. Mr. CHAS. E. CUTRESS has kindly provided me with preliminary identifications.

Twenty-six specimens, up to 5 cm in length, are referred to the genus *Edwardsia.* They closely resemble *E. intermedia*, one specimen of which was taken by the *Albatross* in 1887-88 off the southern coast of Chile from 223 m (MCMURRICH 1893).

A single specimen of *Bolocera pannosa* occurred in the haul. This species was previously collected once (also by the *Albatross)* from off Southern Cali-

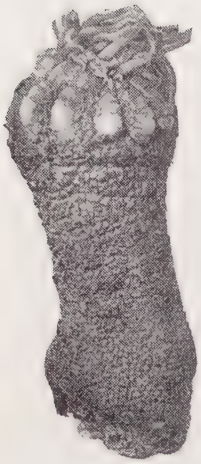


Fig. 7. A specimen of the sea-anemone *Chondrophellia coronata* from the North Atlantic. 2 × nat. size. (After GRAVIER 1922).

fornia at a depth of 757 m. The *Bolocera* are large, many-tentacled sea-anemones. The tentacles, usually long and robust, possess circular muscles at their bases. Through the action of these muscles *Bolocera* easily shed their tentacles when disturbed.

Actinoscyphia plebeia is represented by six specimens. The species was previously known from a single specimen, taken by the *Albatross* off Central Chile at a depth of 1238 m. The broad oral disc of this sea-anemone bears two cycles of tentacles at its periphery. These tentacles (especially the outer ones) are conspicuously thickened on the aboral sides of their bases.

Thirteen specimens belong to the East Pacific and Atlantic species *Chondrophellia coronata* (Fig. 7), which has a known bathymetric range of 600 to 3570 m.

The genus *Amphianthus* is represented by 41 specimens which closely resemble *A. lactea*, also described by MCMURRICH (1893) from a depth of 821 m off Southern Chile. The *Galathea* specimens were on shells of living scaphopods while those collected by the *Albatross* were on dead corals, but amphianthids show little or no host preference.

Finally, there is one specimen which is a new species, perhaps referable to *Telmatactis*, and three specimens which are probably a new species of the genus *Kadosactis*, hitherto known only from the North Atlantic.

Young specimens of *Umbellula* were mentioned above (p. 138). Two other species of sea-pens were represented by about a dozen young colonies, each 10-30 cm high and of a white-yellowish colour. The species belong to the genera *Pennatula* and *Funiculina* which include a great number of littoral species, while about 25 species live on the continental slope and at abyssal depths.

Worms

Dominating animals on soft bottom at all depths are the bristle-worms or polychaetes; these were so frequent at St. 716 that in spite of their moderate size they could be measured in litres: $^1/_2$ l living worms and 2 l empty tubes.

By far the most common was one very big and one smaller species of maldanids (almost without doubt the genus *Maldane)* which live in heavy tubes of black ooze (Figs. 6c and 8, Nos. 7-10). Five or six species could be referred to Aphroditidae and Eunicidae which, likewise, are tube-dwelling. Among the former were a dozen large *Macellicephala* which have their huge probosces everted (Fig. 8, 5-6). This genus has no less than five species in the hadal zone, four of which were even taken exclusively at depths exceeding 6700 m, one being the deepest known polychaete, procured from a depth of 10.210 m in the Philippine Trench (KIRKEGAARD 1956a). A single specimen of the eunicid *Lumbriconereis* was also found at St. 716; this genus is also known hadally. Another eunicid worm was represented merely by several empty tubes (Fig. 8, 1-4); these were tough and semi-transparent and without exception, were found twisted around the spines of sea-urchins (cf. p. 153).

One short and thick specimen of *Travisia* was present (Fig. 8, 12), probably the species *profundi* which is the only deep-sea species of this genus (1000-7300 m); its distribution is extremely scattered (Bering Sea, W. and E. Pacific, E. Atlantic). Of the family Flabelligeridae a large and very hairy species was found. In addition to a few representatives of several more families, there were finally, two species of serpulids; one being the small species mentioned above, found on the shell of *Limopsis* and on the hermit crab, the other a larger species found growing on a piece of cinder from a ship. Fig. 9 shows that, for reasons unknown, the serpulid in the middle has left its safe substratum, the tube being raised almost vertically – like a snake about to attack.

The sipunculids form a group poor in species, ten of which are, however, found at depths exceeding 3000 m, two of these even penetrating a little into the hadal zone (MURINA 1957). Five specimens of the deep-sea genus *Golfingia* were represented at St. 716. Also found was one priapulid; this is the second specimen from that area of *Priapulus abyssorum* (Fig. 10), described by MENZIES (1959) on one specimen taken by the *Vema* at 5680 m about 200 km north of St. 716. The priapulids are likewise poor

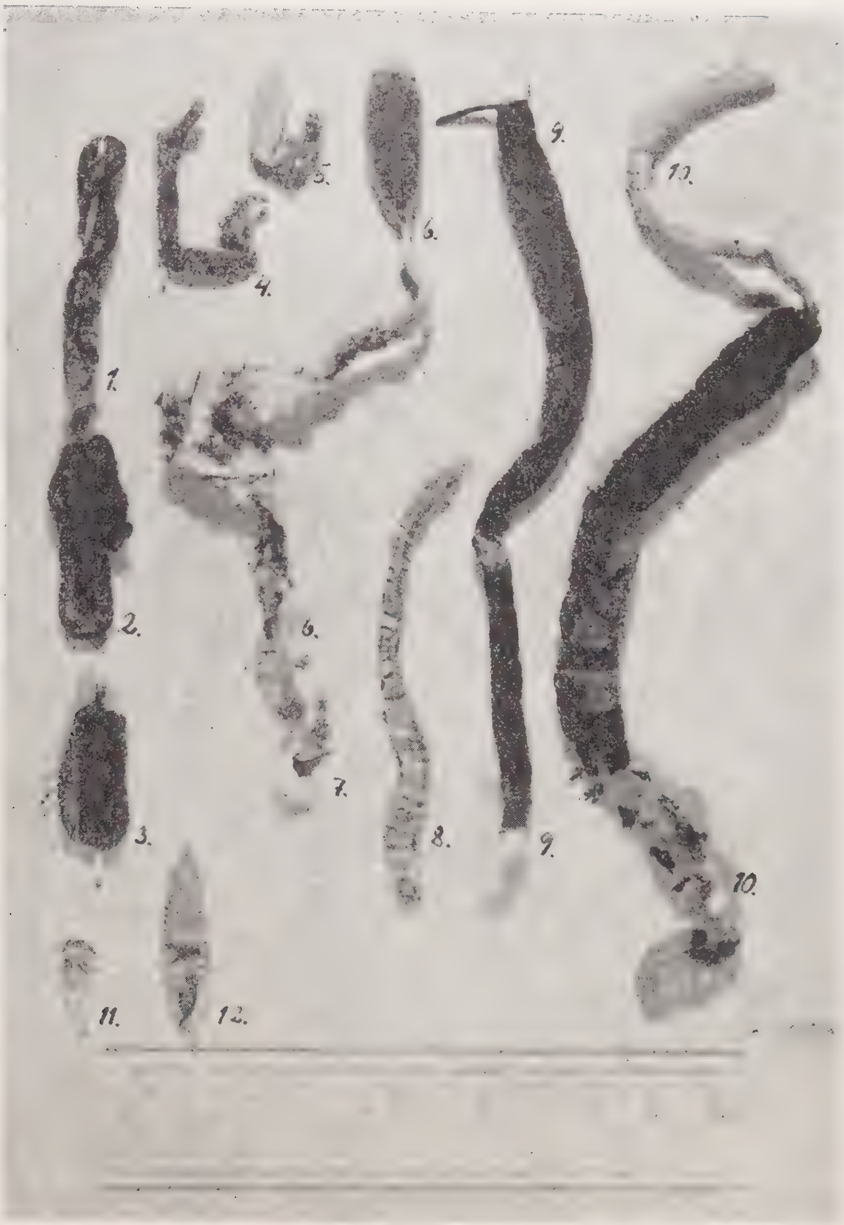


Fig. 8. A few of the larger polychaetes from St. 716. 1-4, empty tubes of an eunicid, twisted around echinoid spines; 5-6, proboscis and complete specimen of *Macellicephala* sp.; 7-10, two species of maldanids, partly or entirely drawn out of the black mud tubes; 11, small ampharetid; 12, *Travisia* sp. Measurement in cm.
(H. V. C. phot.).

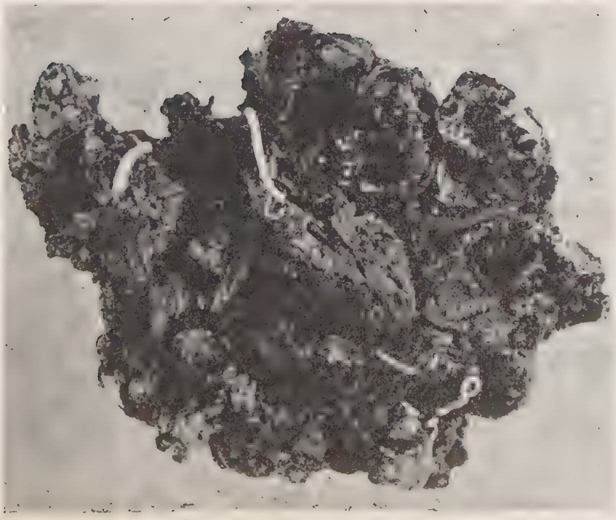


Fig. 9. Piece of cinder with three white serpulid tubes, other polychaete tubes and one *Stephanoscyphus simplex*. $^3/_4$ nat. size.
(H. V. C. phot.).

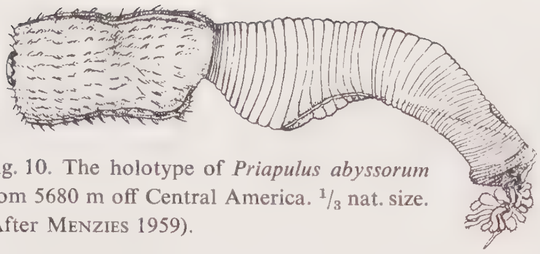


Fig. 10. The holotype of *Priapulus abyssorum* from 5680 m off Central America. $^{1}/_{3}$ nat. size. (After MENZIES 1959).

in species and until this species became known the group was recorded down to a depth of some 500 m only. The species is important as these two records prove tropical submergence of *Priapulus,* a genus which was hitherto regarded as a classical case of bipolar distribution (l. c.).

Finally, mention should be made of a single specimen of a leech, found clinging to a fish of the genus *Bassozetus.* The 3570 m at St. 716 (and 3830 m at St. 607 in the Tasman Sea where another leech was found) are by far the greatest depths from where leeches have hitherto been recorded.

Crustaceans

The number of crustacean species found at St. 716 is no less than a total of 32. The smallest of these are three benthic copepods belonging to the large group of harpacticoids. There are 32 specimens of stalked barnacles of the genus *Scalpellum,* characterized by having both a short and a thick stalk and many plates covering the "head" (capitulum). The genus comprises an enormous number of species (approximately 175), 40 of which are found deeper than 2000 m, although only two seem to reach just into the hadal zone.

Another group of Cirripedia are the ascothoracids which live parasitically on, or more often inside, anthozoans, sea-anemones or echinoderms. The body is enclosed in a mantle; in most species the body segmentation has been lost, and the legs also are unsegmented or have entirely vanished. The mouthparts are stinging-sucking. On the dorsal side of a sea-star *(Eremicaster gracilis,* see Fig. 23) F. J. MADSEN discovered two tiny holes leading in to one or two ascothoracids. It is most likely that they are a species of the genus *Myriocladus,* which lives in sea-stars of this family. Another ascothoracid from an anthozoan host is known from a depth of 4200 m (KRÜGER 1940).

The cumaceans are merely represented by a fragment of one specimen (Fig. 11). The length of the beatifully sculptured carapace is approximately 5 mm, which makes it one of the largest cumaceans known. Unfortunately, most of the slender pleon is missing. However, it is without doubt a new species, probably of the deep-sea genus *Makrokylindrus,* which i. a. comprises the only known hadal cumacean.

In addition to *Neotanais pfaffi* (p. 137), St. 716 yielded another new species of the same genus, *N. armiger* (WOLFF 1956a)[1] and there are still five other species of tanaids which have not yet been studied.

The isopods are certainly one of the dominating deep-sea animal groups. The biggest species from St. 716 is a true giant among isopods, 6 cm long; it is surpassed only by a few species (especially *Bathynomus giganteus)* and is the largest of the asellotes. The three specimens are not only representatives of a new species but also of a new genus and have been named *Paropsurus giganteus* (WOLFF, in

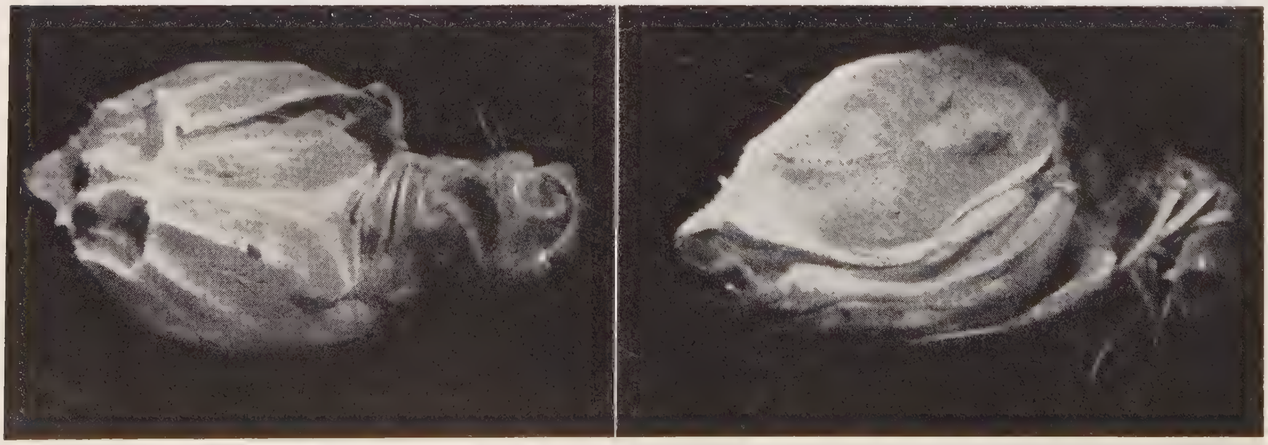


Fig. 11. The well sculptured carapace and the anterior part of the pleon (abdomen) of a cumacean from St. 716 (cf. *Makrokylindrus* n. sp.). 10 × nat. size. (H. V. C. phot.).

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[1] The two tanaids shown on Fig. 7 C in MENZIES *et al.* (1959) are almost certainly *Neotanais armiger* (left) and *pfaffi* (right).

press). As in the genus *Bathyopsurus,* which was first taken by the Swedish Deep-Sea Expedition in 1948, the posterior body segments and the abdomen are greatly swollen. The integument is transparent and very slightly calcified, almost parchment-like. As well as a large amount of unidentifiable detritus, the gut contained a great many diatom tests. In addition to St. 716 in the East Pacific, the *Galathea* also took this species in the Tasman Sea, in the diametrically opposite end of the huge Pacific Ocean – only a few benthic deep-sea isopods are so widely distributed.

The stately, almost 30 mm long isopod *Storthyngura pulchra* (Fig. 12) was originally described by H. J. HANSEN (1897) who gave it the very appropriate species name. It is indeed a splendid animal, chalk-white and provided with elegant spines. It is seldom that an isopod is brought up from the deep-sea with such well preserved legs but, unfortunately, the second pair of antennae have as usual been broken off. HANSEN's material was taken by the *Albatross* in two localities in the Gulf of Panama (2500-2700 m) from where the *Galathea* also procured a single female (3000-3200 m), in addition to the three males from St. 716. Another subspecies of *Storthyngura pulchra* was described by BENEDICT (in RICHARDSON 1901) under the name *Eurycope caribbea* and was taken by the *Albatross* at 1260 m off the West Indies, while a third subspecies is being described on *Galathea* material from 6700 m in the Kermadec Trench N.E. of New Zealand (WOLFF, in press). The genus *Storthyngura* is no doubt the most pronounced abyssal-hadal genus within the isopods; it comprises 30 species and subspecies, all of which – apart from one antarctic species taken between 400 and 750 m – have been collected at depths exceeding 1260 m and always at temperatures ranging between — 1.9 and + 4.9°C. No less than nine species are wholly or partly hadal, and the deepest known species descends to 8430 m in the Kurile-Kamtchatka Trench (BIRSTEIN 1957).

St. 716 yielded two new species of the curious isopod genus *Ischnomesus* which has a long and narrow, stick-like body. One has been named in order to match the beautiful rosy to very faint light green tinge of the calcified integument, which is ordinarily pure white or yellowish. The other species is represented only by the posterior part of the body and pleon of one individual, but the pleotelson is so characteristically pear-shaped and flattened that it was found justifiable to give the species a name despite the head and anterior part still being unknown (WOLFF, in press). Like *Storthyngura, Ischnomesus* is a distinct deep-sea genus: apart from one nordic species which goes up into the littoral zone and two bathyally occurring species, the remaining eighteen are restricted to abyssal depths, three even penetrating into the hadal zone (WOLFF 1956b; MENZIES, in press). One more asellote isopod, *Munnopsis longiremis,* was mentioned above (p. 139).

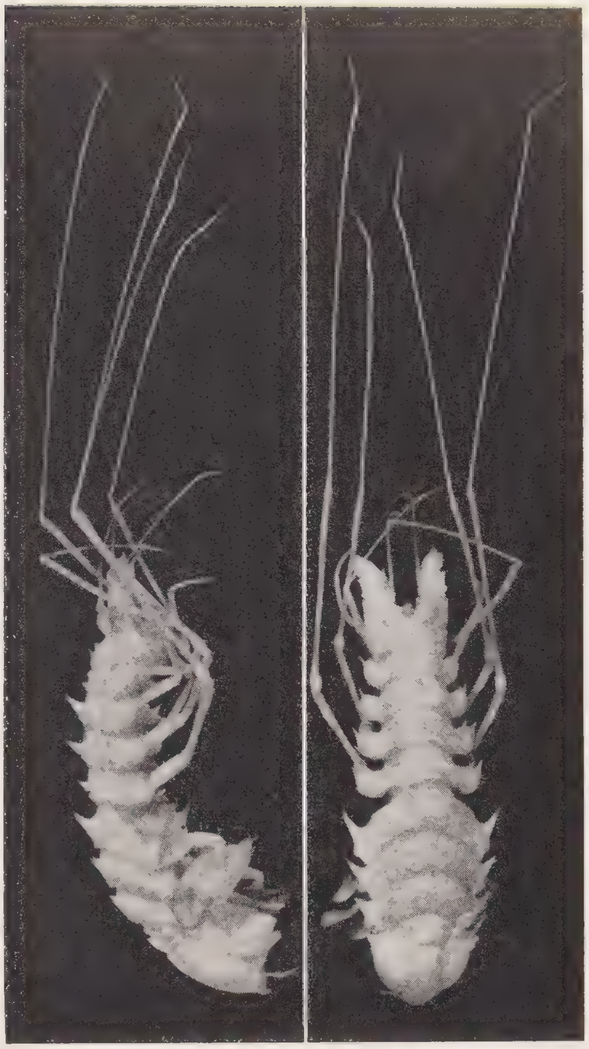
Fig. 12. The magnificent, 30 mm long isopod *Storthyngura pulchra.* Hardly 2 × nat. size.
(H. V. C. phot.).

Five specimens of the large isopod genus *Arcturus* (perhaps representing two species) were caught. Like so many other deep-sea isopods, these *Arcturus* are provided with an abundance of spines (Fig. 13), and in particular, the front pair of walking legs are furnished with very long setae, probably serving to prevent the animal from sinking into the soft bottom. The specimen shown measures 30 mm.

As with the isopods, the amphipods also are among the prevailing groups in the abyssal zone.

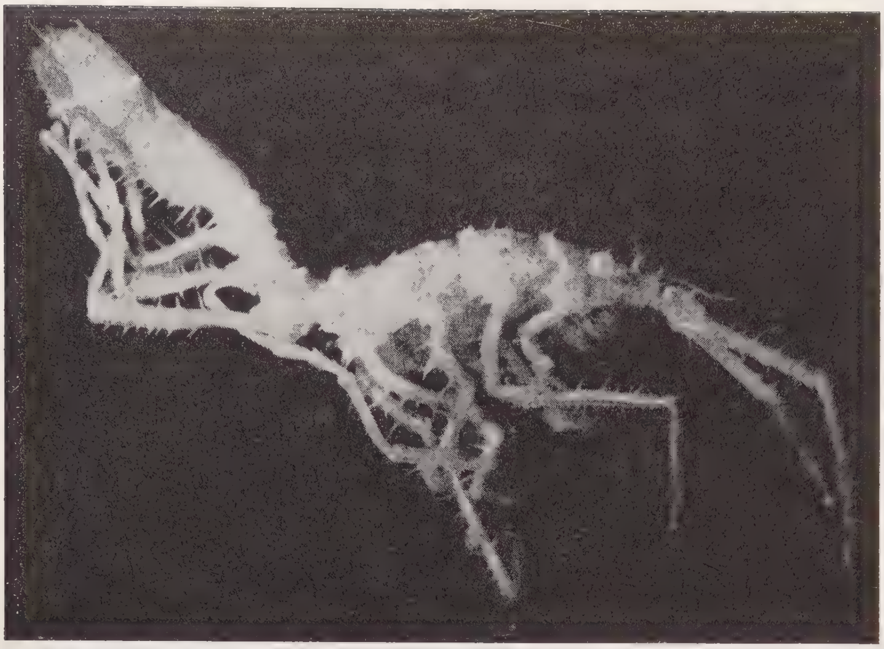

Fig. 13. A spiny isopod of the genus *Arcturus.* 3 × nat. size. (H. V. C. phot.).

The finest amphipod from the expedition is the magnificent, elegantly keeled *Parargissa galatheae,* recently described by BARNARD (1961). The nominate species which is shown on Fig. 14 was taken in the S.W. Indian Ocean off Durban at 4360 m while the single specimen from St. 716 is regarded as a separate subspecies, *P. g. americana;* it is 42 mm long.

Since the other species of the family Hyperiopsidae, to which it belongs, are pelagic, BARNARD (l. c., p. 56) presumes that this is also true of *Parargissa galatheae.* However, in the stomach of the nominate species BARNARD found "slender flakes of material which might be bits of epidermis or comminuted muscle strands, a few falcate flakes, some larger bulky brown particles resembling woody debris, and a very few small hooks, perhaps chitinous parts of polychaetes". This almost exactly corresponds to what I myself have found in the intestine of a very large isopod, *Bathyopsurus nybelini,* of which several specimens have been studied, partly from the Puerto-Rico Trench at 5850 m (Swedish Deep-Sea Expedi-

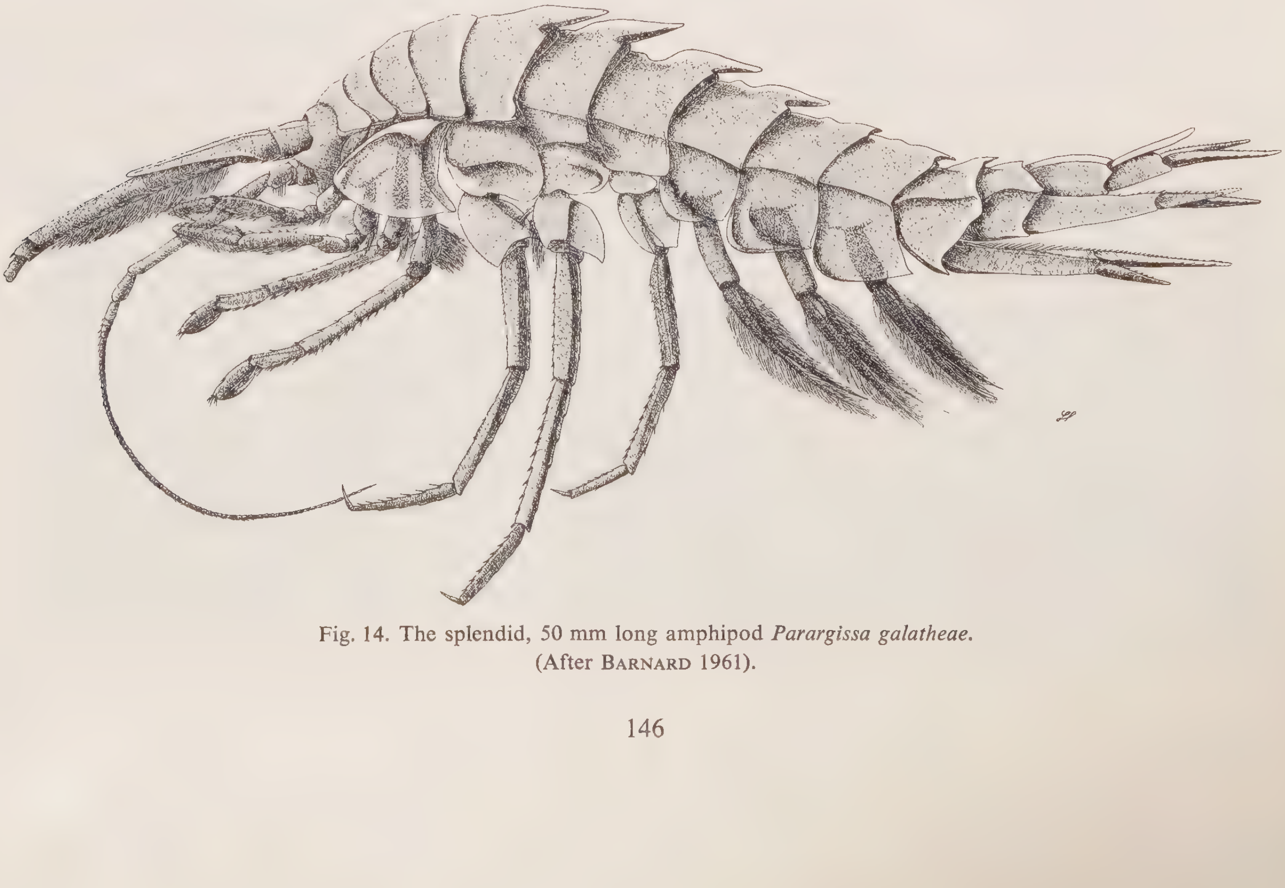

Fig. 14. The splendid, 50 mm long amphipod *Parargissa galatheae.* (After BARNARD 1961).

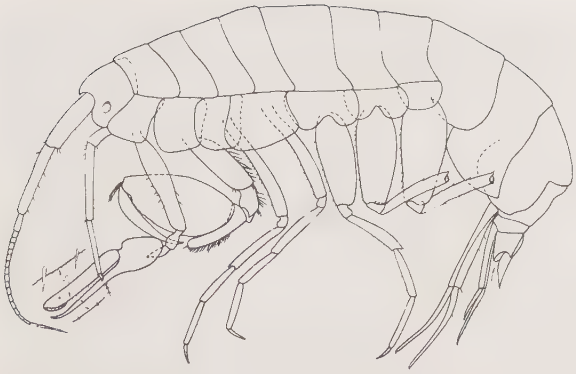

Fig. 15. The amphipod *Leucothoe panpulco* from St. 716. 8 × nat. size. (After BARNARD 1961).

tion) and partly from the Tasman Sea at 4400 m *(Galathea)*. Besides pieces of epidermis with spicules, several muscle fragments, remains of what seems to be an amphipod, and an enormous collection of bits of wood (some with *Campanularia*-like hydroids) there were a few diatom tests, radiolarians and sponge spicules which clearly show that *Bathyopsurus* – like *Paropsurus* (cf. above) – is benthic. I therefore suggest that this is also the case with *Parargissa galatheae*.[1]

Of the two other previously known species of *Parargissa*, one was taken abysso- or hadopelagically in the Kurile-Kamtchatka Trench (at depths between 4190 and 8050 m) and the other was caught – probably bathypelagically – at the Azores (depth to the bottom: 1920 m).

There are seven amphipods of a new species, *Haploops lodo*, which are 7-8 mm long and blind. The species of this genus live in extremely long tubes of mud which project a little over the surface of the bottom. *H. tubicola*, a littoral and bathyal species which is especially common in the eastern Kattegat in North Europe, lies on its back on top of the tube, holding on to the rim with the middle pairs of legs (ENEQUIST 1949, Fig. 63). In this way the pleopods are free and can be used for providing a slight current while the long, setiferous antennae capture the food – which consists of tripton and microorganisms. It is believed that other species obtain their food in the same manner.

The genus *Haploops* contains 12-13 species which range from sublittoral down to 3570 m, *H. lodo* from St. 716 being the deepest record so far. The genus is primarily bathyal in distribution.

A third new species, *Leucothoe panpulco* (Fig. 15), is 9 mm long. Although it is probably not quite blind like the former two, the eyes are poorly developed. There are 21 species in this genus, but only four apart from the present are bathyal or abyssal.

Three or four pale pink specimens of *Rachotropis* were too fragmentary to permit a description. This large genus contains several abyssal species and one hadal representative from 7160 m in the Sunda Trench. The last pair of legs of this species were extremely elongated (DAHL 1959).

Finally, two fragments can be referred to the genus *Epimeria* which contains 19 species. Two new species from the *Galathea* are abyssal and one new species from the *Vitjaz* was taken in a vertical haul from 8000-0 m. All the remainder are bathyal or may occur in shallow water in polar regions.

At least nine species of benthic decapod crustaceans were collected at St. 716. Among the Natantia or true shrimps there are at least two bottom-living species. One is represented by ten beautiful scarlet crangonids and by three specimens of the genus *Hymenopenaeus*. The latter have extremely long, stalked legs – presumably again, an adaptation to the soft bottom. The legs are also provided with a tuft of fine setae at the base of the distal joints. It is impossible to decide whether some of the ten other species of shrimps were taken pelagically while the trawl was on its way up, or at the bottom; we have reason to presume that a couple of the large, 25 cm long penaeid species spend at least part of their life at the bottom.

The most striking reptant decapod is, of course, the hermit crab *Probeebei* (p. 136). There are two species of Galatheidae of the genus *Munidopsis*. As their eyes are vestigial they are, without doubt, blind, but in compensation the antennae are strongly developed. *Munidopsis* comprises more than 100 species, but in spite of several vigorous attempts, no natural division of the genus has so far been brought about. These various species are found exclusively in the bathyal and abyssal zones. The only exception is one species which, living at a depth of only a few meters, has become adapted to life in the dark, subterranean caves in a salt lake on Lanzarote – one of the Canary Islands. The lake is in direct connection with the sea and its local crustacean is as pale and blind as its deep-sea relatives. – The decapods differ from all other important groups of marine animals in having apparently a sharp lower limit at comparatively moderate depths (a good 5000 m), probably due to the fact that almost all decapods are

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[1] Unfortunately, the specimen from St. 716 lacked all the internal parts of the body, thus preventing a study of its stomach contents.

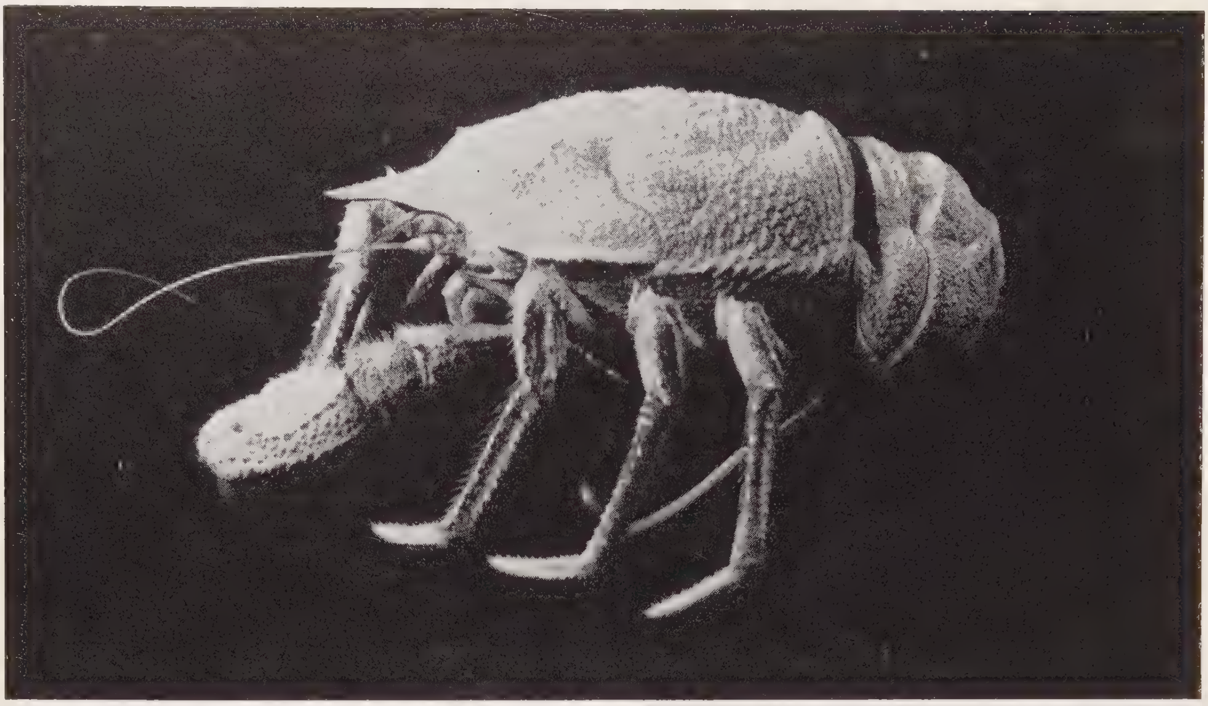

Fig. 16. An almost 20 cm long, new species of the anomuran genus *Munidopsis*. (H. V. C. phot.).

predators (or scavengers) and thus less adapted to life at the greatest depths. At least a dozen species of *Munidopsis* occur deeper than 3000 m, and four even deeper than 4000 m. Consequently, this genus includes more abyssal species than any other genus of Decapoda.

One of our two *Munidopsis* species is available in five specimens and seems to be closely related to *M. antonii*. This is presumably cosmopolitan, having previously been reported from such scattered areas as Australia, Chile and the Azores at depths between 2500 and close to 4000 m. When freshly caught, the specimens were white with orange eggs and yellow eye rudiments; the length is 10 cm. I have not been able to identify the other, which is most probably a new species. This is represented by one splendid individual (Fig. 16) measuring barely 20 cm and differing from nearly all other species by its broad and flattened carapace.

The most exciting group of decapods from greater depths are the Eryonidae. The first representatives of this family became known about a century ago as fossils; they date back as far as the Triassic, having their main occurrence in Jurassic. The fossil eryonids were shallow water forms with large, well developed eyes. When the *Challenger* Expedition in the 1870's found living relatives of these fossils in the deep-sea much attention was focused on the event, confirming as it did the popular theory that the really ancient forms and "missing links" have been preserved in the deep-sea right up to the present time. As far as the abyssal zone is concerned, this has proved to be without foundation, perhaps with the exception of *Neopilina,* one genus of Eryonidae, and a few other examples.

This abyssal genus of Eryonidae is *Willemoësia* which occurs between 2500 and 4400 m. From St. 716 there are eight individuals (Fig. 17), the longest being about 13 cm. Among the species of this genus our eight specimens seem to be most closely related to *W. leptodactyla* and, in particular, to a few individuals from 2500 m off Chile. However, a careful revision of the entire genus is badly needed before a safe decision can be reached.

Characteristic of these lobster-like creatures is the flattened carapace and also the exceptionally meagre chelipeds. In addition, each of the succeeding four pairs of legs are provided with a set of claws and all that remain of the eyes are useless rudiments. The integument is soft and flexible, being less calcified than that of other reptant decapods.

Below in Fig. 17 are two larvae which, as an exception, are not from St. 716 but were taken at St. 726 in the Gulf of Panama (3270-3670 m), where we obtained eleven adult specimens of the same species and, in addition, four larvae. Such

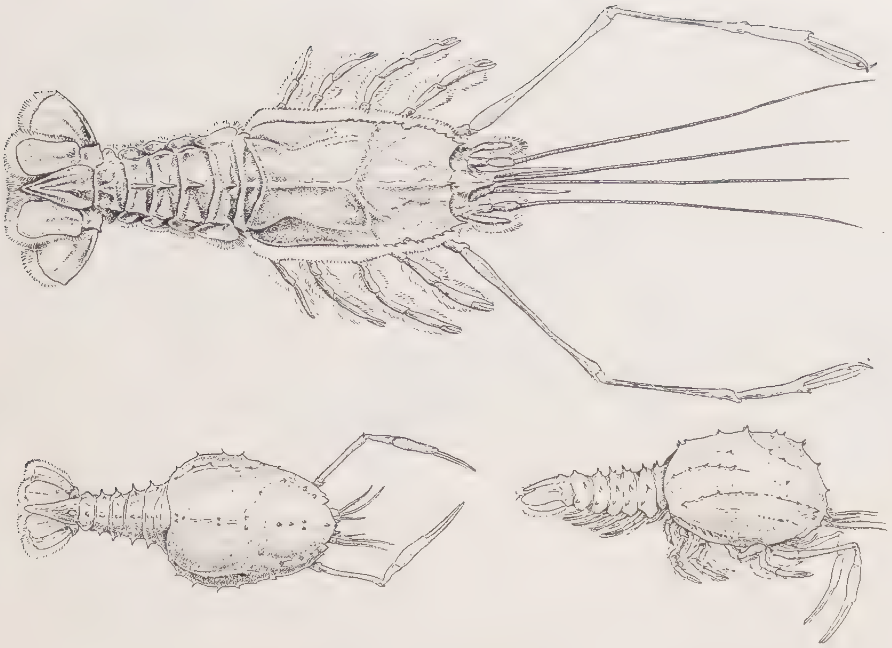

Fig. 17. The eryonid *Willemoësia;* above, the adult and below, two *Eryoneichus* larvae. Nat. size. (After "The Galathea Deep Sea Expedition 1950-1952").

larvae have been known for some time previously and are all referred to the genus *Eryoneichus*. However, their correct relationship was for a considerable time subject to discussion i. a. due to the largest specimens found having, apparently, fully developed external sexual organs. No specimens of *Eryoneichus* have ever been found carrying eggs, however, nor are there any known post-larvae which could justly be considered juvenile forms of the adult eryonids. There is no doubt, therefore, that *Eryoneichus* larvae are developmental stages of *Willemoësia,* or of *Stereomastis* or *Polycheles* – the two other genera of the family. Nevertheless, despite BERNARD's great work (1953) on the *Eryoneichus* of the Danish *Dana* Expedition[1] only three "species" of *Eryoneichus* can safely be referred to an adult species, none of them being a *Willemoësia.* Accordingly, it is very fortunate that larvae and adults were taken here in the same haul; a preliminary study seems to show that morphologically they are in fine agreement.

Finally, from St. 716 there are three small, roundish crabs, only 10 mm broad. Their claws are weak while their two hindmost pairs of legs are short, hooked at the tip and twisted backwards and upwards to carry a sponge (or more rarely a bivalve shell) above the carapace, serving as a shelter while the crab is walking about.

I have been unable to determine these crabs; they almost certainly belong to a new species which, strangely enough, must be referred to the genus *Ethusa* – of which the twenty known species occur from quite shallow water down to 1900 m. The surprising thing is that they do *not* belong to the closely related genus *Ethusina* which is the most pronounced bathyal-abyssal genus of crabs (with eight species from 500-4300 m). Only about 125 of a total of about 3500 crab species go deeper than some 200 m, and a correspondingly low number of species occur in shallow water in boreal and arctic areas: consequently, the crabs are almost exclusively a warm-water group.

Pycnogonids

The sea-spiders were dealt with when discussing *Colossendeis colossea* (p. 138). Another two species of this genus are present, one being represented by four specimens of *C. cucurbita.* This species owes its name to the cucumber-shaped proboscis and may measure up to 33 cm from the tip of one leg to the end of the opposite. The species was previously taken south of Australia, at the Galapagos Islands and off the Azores at depths from 3300 m to 4150 m. The *Galathea* collected the four specimens from St. 716 at 3570 m and five more in the Kermadec Trench and the Tasman Sea at 2640 and 4400 m – i. e. a purely abyssal species with a very wide distribution.

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[1] Above (p. 139) i. a. *Stephanoscyphus* was mentioned as an example of the abundant collections of benthic deep-sea animals procured by the *Galathea*. Even so, this wealth of material is easily surpassed by the enormous *Dana* collections of *pelagic* forms, particularly in comparison with all previous and subsequent activities in this environment. This can be illustrated by an obvious example: Before the *Dana* Expedition a total of 57 specimens of *Eryoneichus* were known, distributed on 13 species, whereas the *Dana* collected 255 specimens, representing 34 species.

The other is *C. macerrima,* represented by 15 specimens at St. 716. It is likewise to be found in all oceans, but stands temperatures exceeding 10° C., since in the Indo-Malayan area it goes up to about 500 m depth. Apart from St. 716, the *Galathea* took specimens at 3400 m in the Mozambique Channel and at 3300-3700 m in the Gulf of Panama, all these records being deeper than any known previously (FAGE 1956b).

Molluscs

St. 716 is also rich in molluscs, having yielded a total of 14 species. Of the primitive scaphopods or tusk shells, 50-60 individuals of *Dentalium megathyris* are present (Fig. 6e), known from a dozen earlier finds, all at great depths (1450-4100 m) along the entire Pacific coast of America.

We may assume that this large species (up to 7 cm long) is also buried in an oblique position similar to the shallow water forms (only the pointed tip of the shell with a hole for the respiration water being visible above the bottom), and that it also feeds on foraminifers which are caught by a large number of thin, sticky tentacles, situated on the head and swollen at the tips.

The haul included many gastropods, amongst them one large *Tractolira sparta* which has previously been taken in the Gulf of Panama between 3000 and 4100 m (DALL 1908). It is the only species within the genus, is 7 cm long and resembles a slender red whelk. Two small individuals of the closely related genus *Fusus* have not yet been determined to species, neither has a small, 2 mm long *Cocculina.* All the species of this genus occur in fairly deep water and are considered to be rather primitive. The shell is cap-shaped, and it was first taken for a juvenile *Neopilina;* in all probability it is a new species.

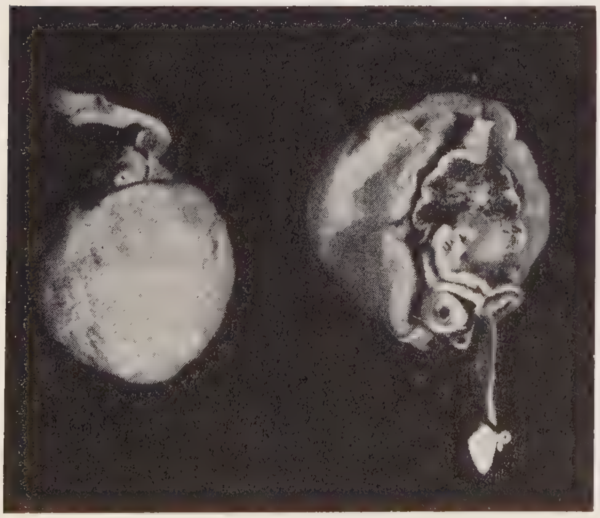

Fig. 18. Two unknown gastropods, perhaps of the family Lamellariidae. 1.3 × nat. size. (H. V. C. phot.).

The deep-sea genus *Pleurotomella* is represented by a single specimen which may be *agonia*, previously taken in the East Pacific by the *Albatross.* In addition, eleven *Stilifer*-like small snails were found. The species of this genus are ecto-parasites on various kinds of echinoderms, boring by means of the proboscis through the skin of the host. It is quite likely that the eleven *Stilifer* were living on some of the many sea-stars from this haul. Although it is not identical with it, the species closely resembles an undescribed, hadal *Stilifer* which was taken by the *Galathea* at a depth of 8300 m in the Kermadec Trench.

There are two further gastropods, purple in colour and almost ball-shaped (Fig. 18). Their systematic position is uncertain. They may belong to the family Lamellariidae which are definitely prosobranchs, but whose shell, nevertheless, is partly or wholly reduced. Or perhaps they are something quite new and still more exciting.

Apart from the above mentioned *Limopsis* (p. 139) four more bivalve species were found, at least two of which are new. One is a beautiful, approximately 5 mm long, species of the deep-sea genus *Dacrydium* (Fig. 19) which is related to the common mussel. Two minute bivalves (1 mm) can be referred to *Kelliella,* a genus of which the *Galathea* obtained two additional hadal species, from the Kermadec and Sunda Trenches, respectively. Another deep-sea genus, *Verticordia,* is represented by four specimens which are 5-6 mm long. Finally, there are two large individuals of *Cuspidaria* both 40 mm long (Fig. 20), belonging to a small group of bivalves, remarkable in being predatory. While all other bivalves feed on plankton organisms or very fine organic material, the species of *Cuspidaria* are unique in having a muscular septum. Its rhythmic movements draw as well as water, food (crustaceans and polychaetes) into the mantle cavity. From here, palps forward the prey into the big mouth whereupon it continues into the roomy, muscular stomach.

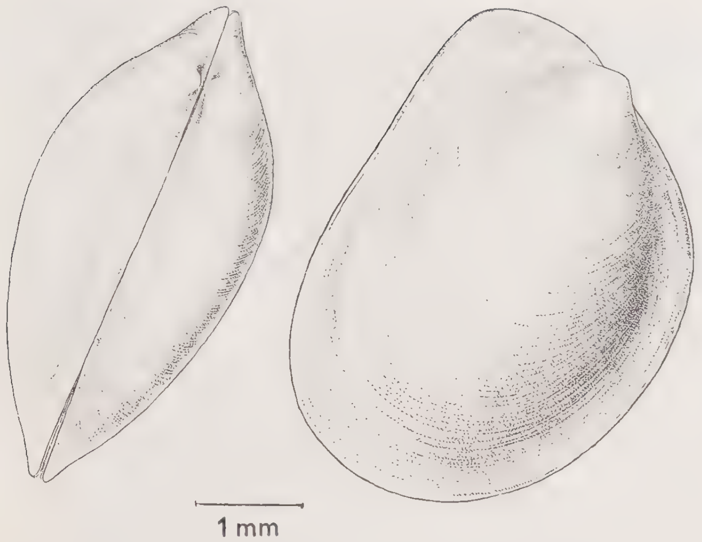

Fig. 19. A handsome new species of the mytilid *Dacrydium*.
12 × nat. size.
(P. H. Winther del.).

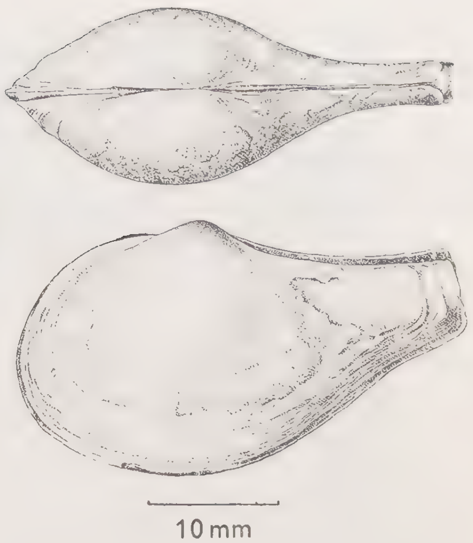

Fig. 20. A new species of the carnivorous bivalve *Cuspidaria*.
1,5 × nat. size.
(P. H. Winther del.).

Among the molluscs is a group of worm-like animals, Solenogastres or worm molluscs, which is poor in species. The shell is missing, but, as in gastropods, there is a radula. At St. 716 15 specimens of *Chaetoderma* were collected. This genus comprises about 30 species, most being bathyal and only one previously recorded from the abyssal zone. The specimens probably belong to *Chaetoderma californicum* which was previously known in one specimen at 1100-1200 m off Southern California (Heath 1911).

Echinoderms

This group is extremely abundant in the deep-sea, in particular the holothurians or sea-cucumbers. At St. 716 these are represented by no less than 14 species with 512 individuals!

The holothurian order Elasipoda is the highest systematic taxon of marine animals almost exclusively restricted to the abyssal zone. The above mentioned *Scotoplanes* (p. 140) and five other species from St. 716 belong to this order. Dorsally, many elasipods have one or more particularly thin-skinned papillae, which, since no member of the group has water lungs, have been interpreted as respiratory organs. The species *Psychropotes longicauda* has an especially impressive papilla which is almost like a tail (see Fig. 21 which illustrates its suggested movements along the bottom). From St. 716 are four specimens, the largest having a body length of 21 cm. The distribution of this species is typically cosmopolitan, as many individuals previously regarded as being different species from different oceans have since proved to pertain to this species; the depth range is 2200 m to almost 5000 m.

Further, there are 29 *Oneirophanta mutabilis*, provided with numerous, long dorsal papillae. This is one of the most common holothurians and is also distributed in all three oceans. It was hitherto known from a depth of 1800-5300 m; the *Galathea* caught specimens at seven stations, i. a. in the Kermadec Trench at 5900 m. A new species of *Peniagone* is represented by 41 specimens, and there are two species of *Benthodytes (typica* and *incerta)*. The former of these is a cosmopolitan and both are restricted to the abyssal zone. Both *Peniagone* and *Benthodytes* have a representative in the hadal zone, the former in the Kermadec Trench, the latter in the Banda Trench (B. Hansen 1956).

Among the other orders of holothurians there are 51 specimens of *Synallactes aenigma*. It was taken once by the *Albatross* in the vicinity of this area and was not known elsewhere. The large, cucumber-shaped *Pseudostichopus mollis* has – as the name indicates – no spicules; it is represented by about 100 specimens. A single *Paroriza* is a new species. The two latter genera both have a hadal species (the Banda Trench and the Kermadec Trench, respectively).

The ninety *Staurocucumis abyssorum* (about 10 cm long) are also cucumber-shaped. Their tentacles are branched like a tree, and they feed on plankton. A closely related species is the almost spherical,

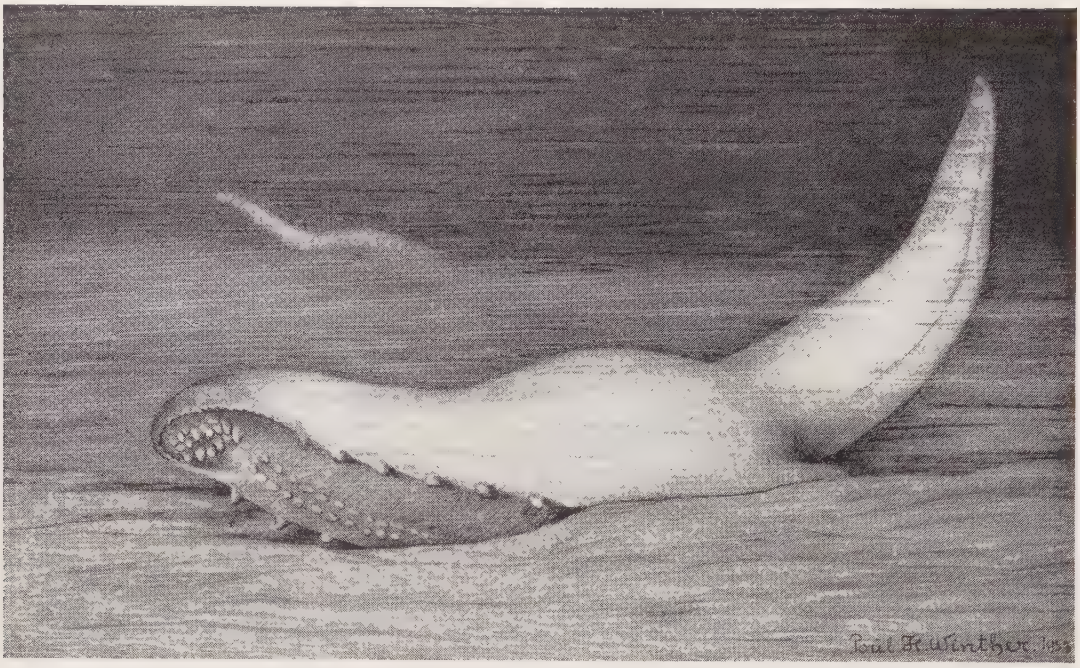

Fig. 21. The holothurian *Psychropotes longicauda* ploughing its way through the surface of the ooze, with the "tail" raised high. About $^1/_2$ nat. size. (After "The Galathea Deep Sea Expedition 1950-1952").

spined *Sphaerothuria bitentaculata* (Fig. 22) which is also a cosmopolitan. The same applies to *Molpadia musculus* of which 51 specimens were collected, whilst another equally numerous species *(granulata)* of the same genus, seems to be limited to the East Pacific. Finally, there is the extremely common *Protankyra brychia* which lives at depths between 900 and 5200 m and was taken at numerous *Galathea* stations. We have vivid memories of this small creature – the tough brown body has an extraordinary ability to get entangled in the meshes of the net and often it might take hours to disengage the hundreds of specimens.

The crinoids or sea-lilies do not take long to survey. All that is found are fragments of three small stalked individuals of 5-10 cm length, belonging to *Bathycrinus,* which is the only abyssal genus.

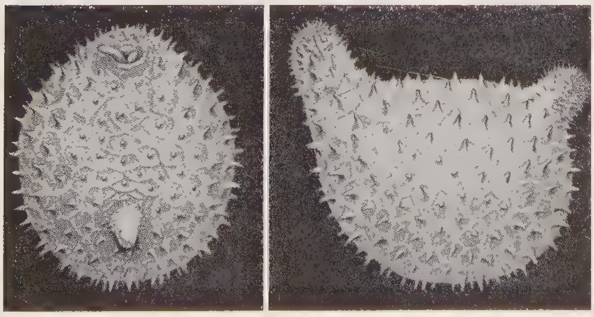

Fig. 22. The curious, almost spherical holothurian *Sphaerothuria bitentaculata* from above and from the side. 2.5 × nat. size. (After Ludwig 1894).

There are, however, 210 specimens of asteroids or sea-stars, composed of seven or eight species. Half of them belong to *Dytaster gilberti*, which may reach a size of 25 cm, and apart from having a splendid orange colour, resembles the common *Astropecten*. Unlike the following species it takes its food from the surface of the bottom. It is limited to the Eastern Pacific between 3200 and 4300 m.

The 86 *Eremicaster gracilis* only grow to a size of 11 cm in diameter and are greyish in colour. They are deposit feeders and presumably bury themselves in the bottom. As in other species of the family, the central part of their dorsal side may be raised in the shape of a cone (Fig. 23), in young individuals even in a pointed tip. This cone is probably of great importance to the respiration as it keeps a passage open through which water may be exchanged from the narrow cavity surrounding the buried animal. The specimen in Fig. 23 contains one or two parasitic ascothoracids (p. 144). Around the mouth, or in the furrows of a few other specimens were some very minute hydroids, all of which were about 1 mm high and provided with only three tentacles. They may be of the same species as those on the shell of *Neopilina*. *Eremicaster gracilis* is typically abyssal,

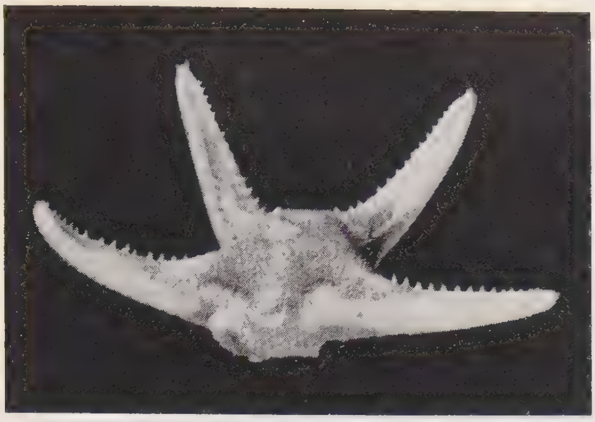

Fig. 23. On the dorsal side of the deposit feeding sea-star *Eremicaster gracilis* a cone is visible in the centre; this probably contributes towards providing a water current which enables the buried animal to breathe. This specimen maintains one or two parasitical ascothoracids. Nat. size. (H. V. C. phot.).

the 18 finds having been made between depths of 2609 and 5200 m and at temperatures of 1.3° to 2.6° C. Besides the 18 finds along the entire American west coast it is also recorded from the recent Russian deep-sea explorations near Kamtchatka (MADSEN 1961 a, Fig. 39).

A preliminary identification has referred one pillow-shaped, violet sea-star with a size of 15 cm to the genus *Hymenaster*. Another specimen of 13 cm may be "*Mediaster*" *elegans* which is known from the Gulf of Panama (1800-3300 m) but is somewhat divergent; the quotation marks indicate that the species *elegans* does not belong to the genus *Mediaster* (F. J. MADSEN, verbal communication). A couple of small, whitish, much damaged sea-stars should perhaps be referred to *Pteraster*, and finally, there are seven multi-branched brisingids which are likely to be of the genus *Freyella* and are represented by 2-3 species. One of the four specimens of a beautiful 12-armed species has miraculously been preserved with most of its arms (Fig. 24), as has, to a certain extent, a 6-armed specimen. Moreover, there are two central discs, one 8-armed and one 13-armed – plus a great many loose arms!

Five species of ophiuroids or brittle-stars are present in more than 300 specimens. Three species belong to the family Ophiolepidae which lack spines, are strongly calcified, and take their food on the surface of the bottom. Of *Ophiura irrorata* (Fig. 6a) there are no less than 162 specimens, a fact indicating that this species – like its nordic relatives – may be found in great abundance over limited areas, forming a whole layer of animals. It is a cosmopolitan and known from 125-3570 m. A similar distribution, although with a somewhat deeper occurrence, has *Ophiernus vallincola*, of which there are twenty specimens, while only eight *Ophiosphalma glabrum* (Fig. 6a) were found. The latter is limited to the Eastern Pacific between depths of 1600 and 5200 m.

The genus *Amphiura* is represented by about 100 specimens of a species which is almost certainly *A. serpentina*. It is also restricted to the Eastern Pacific (about 800-2000 m) and is a frail, thin-armed creature which lives buried in the bottom. Much more sturdy is *Ophiacantha cosmica*, whose arms are covered with a large number of spines. It is to be found in all seas and at depths between 640 and 4840 m. Not only the spines, but also the very flexible arms enable the animal to cling to the residences preferred: sponges, sea-pens, water-logged remains of wood, pieces of lava and other rock, etc.

Three species of echinoids or sea-urchins were taken at St. 716. There were no less than 126 *Aporocidaris milleri* with shell diameters ranging from 2 to 35 mm and spines with a maximum length of 60 mm. They were often overgrown with the twisted tubes of a polychaete (Fig. 8, 1-4). In this way the worm is kept free of the sediments, since this sea-urchin crawls on the bottom surface with its spines slightly raised. It was previously taken in the tropical East Pacific between 3000 and 3900 m depth.

Of the extremely thin-shelled, violet, irregular *Urechinus loveni*, the macerated remains of a couple of fairly large specimens are present. This species has practically the same regional and vertical distribution as the former sea-urchin. Finally, there are two greyish specimens of the irregular species *Aëropsis fulva*, shaped like a large date. It occurs in the Pacific between 1500 and 5200 m. Like *Urechinus* it no doubt lives buried in the ooze.

Ascidians

A total of 41 species of ascidians or sea-squirts go deeper than 3000 m; of these, the *Galathea* secured two at St. 716. One, *Dicarpa simplex* (Fig. 25), was represented by eight well preserved specimens which are about 5 cm long. The body is raised from the bottom by means of a stalk which is safely anchored with fine suckers.

The presence of a stalk in glass-sponges, sea-pens, sea-lilies, some ascidians, etc. is generally regarded as an adaptation for lifting the animals above an

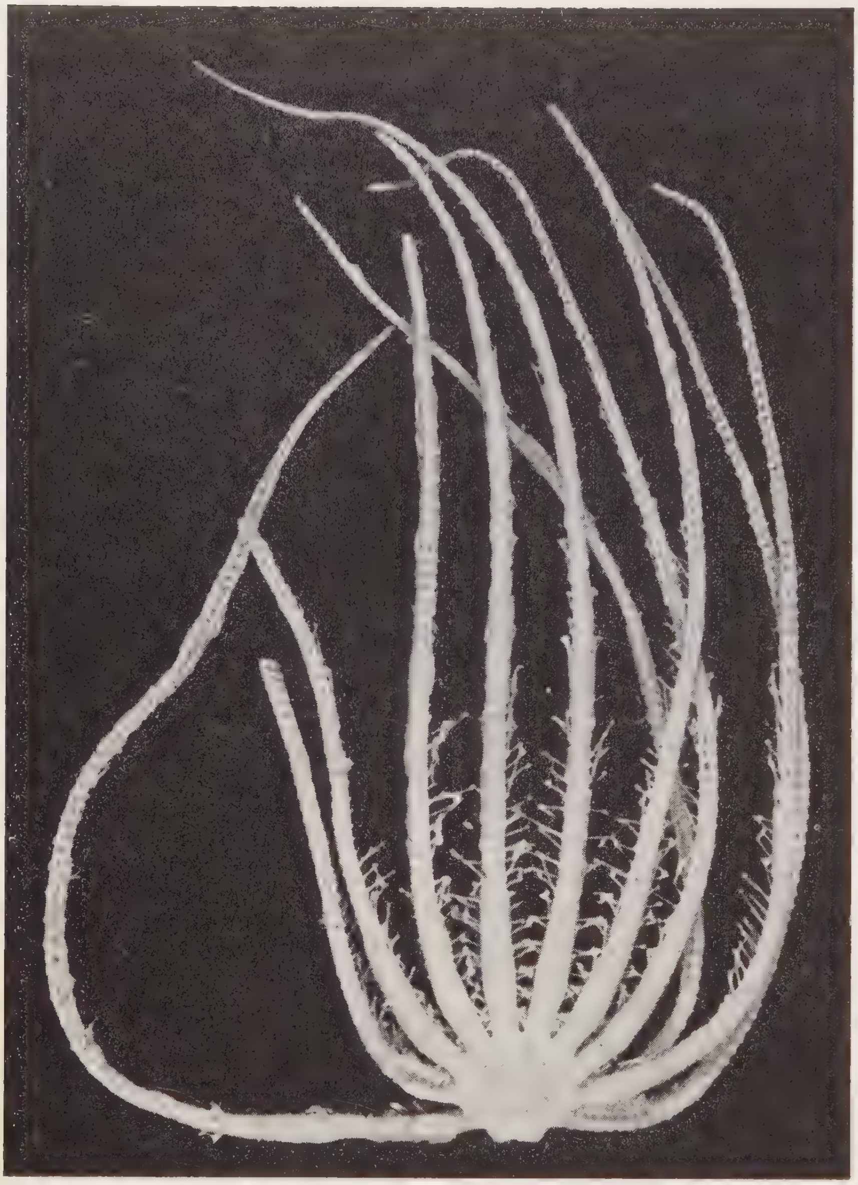

Fig. 24. A well preserved specimen of the 12-armed brisingid *Freyella*. Nat. size. (H. V. C. phot.).

upper, semi-liquid layer of ooze. However, deep-sea photographs indicate a fairly firm surface in many places; MADSEN (1961b, p. 201) suggests that the stalk may rather, perhaps be advantageous in raising sessile animals above an oxygen-poor water layer close to the bottom.

Dicarpa simplex was first taken in 1948 by the Swedish Deep-Sea Expedition at 4600 m depth in the western Atlantic. As it was collected by the *Galathea* both in the Kermadec Trench (N. E. of New Zealand at 2470 m) and in the eastern Pacific, it soon proved to be cosmopolitan (MILLAR 1959). The other species was found to be too fragmentary to allow identification.

Fishes

Only one of the fish species from St. 716 (*Galatheathauma*) has been worked up so far (cf. p. 137).

According to the latest statement (NYBELIN 1957), there are altogether 69 species of bottom fish from a total of 137 localities deeper than 3000 m. To this should be added the fish known from the greatest depths, *Careproctus amblystomopsis,* taken by the Russian *Vitjaz* Expeditions at 7200 m in the Kurile-Kamtchatka Trench and at 6160 and 7590 m in the Japan Trench (ANDRIASHEV 1955; RASS 1958).

The fish family richest in deep-sea species is the Brotulidae. Most of the species seem to have a

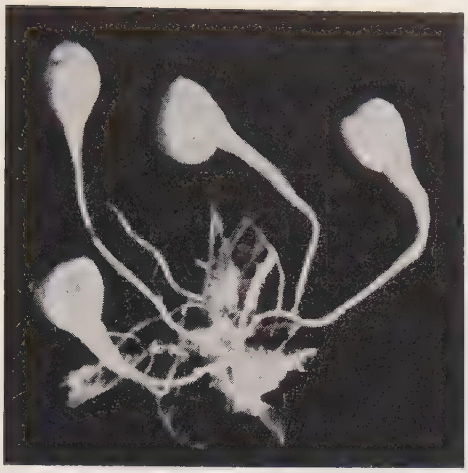

Fig. 25. Some specimens of the stalked ascidian *Diparca simplex*. Nat. size. (After MILLAR 1959).

rather restricted distribution both regionally and vertically. The majority are bathyal and abyssal, and among the limited number occurring at lesser depths several are cave forms or species living buried. Their shape is always longish, with a relatively large head, the body becoming prolonged into a long and narrow, pointed tail; consequently, they are not good swimmers. Most of them are pale brownish or colourless, though not infrequently they are blackish or are of a dark violet colour on the head and gill operculum. Many have vestigial eyes. Besides *Bassogigas* mentioned on p. 137, the following closely related genera were represented at St. 716: *Bassozetus* with 26 individuals up to 30 cm long; only one of the seven species of the genus is bathyal, the others are abyssal, and one lives as deep as 5600 m. Further, there were five individuals of *Porogadus* which has four bathyal and seven abyssal species, and fifteen *Mixonus,* a genus whose three species are abyssal (GREY 1956).

Another very important deep-sea fish family is Macrouridae. They have almost the same body shape as the brotulids, but in actual fact, there is no close relationship between them. The biggest fish caught at St. 716 belongs to this family. It is a species of *Nematonurus,* about 86 cm long (Fig. 26); there were also two somewhat smaller specimens. *Nematonurus* comprises one cosmopolitan species (280-4600 m), one species from the Eastern Pacific (2500-4000 m), and one antarctic species (2800-3250 m).

The four specimens of Alepocephalidae were mentioned above (p. 137).

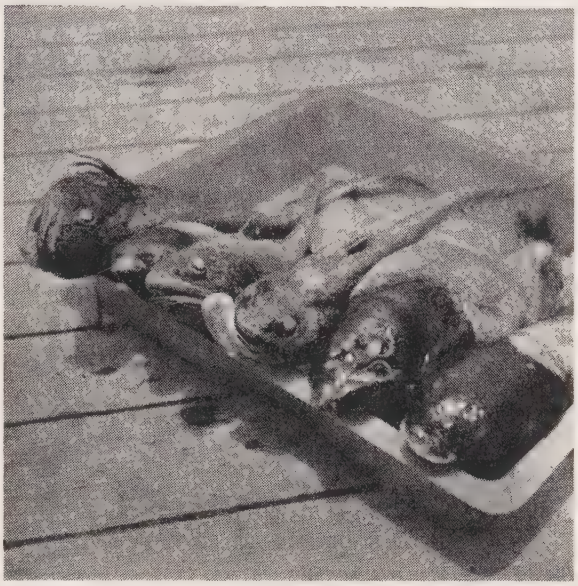

Fig. 26. From left to right: A macrourid *(Nematonurus),* 86 cm long; an alepocephalid fish; two more *Nematonurus;* two more alepocephalids. The reduction in pressure has forced the stomach out through the mouth of the fish in the middle. (MOGENS HØYER phot.).

THE DOMINATING ANIMAL GROUPS

In table 1 the number of species and individuals[1] of the various animal groups from St. 716 have been compared. Moreover, it was found practicable to include in Table 1 the number of individuals obtained from a total of 11 trawlings carried out by the *Vema* between 3290 and 3700 m in the immediate vicinity of St. 716 (MENZIES *et al.* 1959, Table 1 and MENZIES *et al.* 1961, Table 1). Unfortunately, no information about the number of species is available.

The amazing difference in numbers of individuals of the various groups captured by the two expeditions must, without doubt, partly be ascribed to the type of gear applied. As mentioned above (p. 130), the *Galathea* used a large herring otter trawl. The size of the meshes varied from 80 mm at the head to 14 mm at the cod end. Nevertheless, a fairly high number of small and very small animals (5-1 mm) was obtained, due to a 25 litre canvas bag being placed at the cod end of the trawl which helped to bring up large or smaller quantities of bottom se-

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[1] When estimating the number of individuals each colony of colonial animals has been counted as one individual only.

Table 1. The number of species and specimens of various groups of benthic animals from *Galathea* St. 716, the number of specimens of the same groups from *Vema* 15, Sts. 128-129 and 131-139, and the relative order of group abundance.

Animal groups	*Galathea* St. 716 (3570 m)			*Vema* Sts. 128-129, 131-139 (3290-3700 m)	
	No. of species	No. of specimens	Relative order of abundance (1-10)	No. of specimens	Relative order of abundance (1-10)
Porifera	**3**	**c. 41**		**21**	
Coelenterata	**16**	**c. 137**		**141**	
Hydroidea	3	4		5	
Scyphozoa *(Stephanoscyphus)*	1	13		101	**6**
Alcyonaria	1	8		15	
Pennatularia	3	17		0	
Coral	0	0		3	
Actiniaria	8	95	**6**	17	
"Vermes"	**c. 23**	**c. 317**		**1142**	
Aschelminthes	0	0		52	**10**
Polychaeta	*c.* 20	*c.* 310	**3**	1090	**1**
Hirudinea	1	1		0	
"Gephyrea"	2	6		0	
Crustacea	**c. 32**	**c. 208**		**742**	
Copepoda	1	3		6	
Ostracoda	0	0		15	
Cirripedia	2	32		1	
Nebaliacea	0	0		8	
Cumacea	1	1		41	
Tanaidacea	7	60	**8**	221	**4**
Isopoda	7	50	**10**	198	**5**
Amphipoda	5	12		250	**3**
Decapoda	*c.* 9	*c.* 50	**10**	2	
Pycnogonida	**3**	**18**		**1**	
Mollusca	**14**	**132**		**539**	
Monoplacophora *(Neopilina)*	1	10		1	
Solenogastres	1	15		80	**8**
Scaphopoda	1	55	**9**	33	
Gastropoda	6	18		51	
Bivalvia	5	34		374	**2**
Brachiopoda	**0**	**0**		**1**	
Bryozoa	**0**	**0**		**89**	**7**
Echinoderma	**30**	**1171**		**104**	
Holothurioidea	14	512	**1**	25	
Crinoidea	1	3		2	
Asteroidea	7	210	**4**	7	
Ophiuroidea	5	315	**2**	67	**9**
Echinoidea	3	131	**5**	3	
Pogonophora	**0**	**0**		**3**	
Ascidiacea	**2**	**10**		**16**	
Pisces	**9**	**66**	**7**	**0**	
Total	**c. 132**	**c. 2100**		**2799**	
Average per trawling	**c. 132**	**c. 2100**		**256**	

diments (Fig. 2). Careful washing through sieves with a mesh diameter of 1 mm brought the tiny creatures to light. The *Vema,* however, used a very small dredge which could be towed by a hydrographic wire. The opening was only 1 m wide and 10 cm high; the bag was 3 m long and made of nylon with a mesh diameter as low as 0.5 mm. The sorting of the material, which usually consisted of about a quart of sediment plus animals, was performed under a binocular microscope.

Due to the small size of the gear it is obvious that the *Vema* could not capture many, if any, of the larger, faster or firmly anchored benthic animals like sea-pens, sea-spiders, fish and above all, echinoderms. It is equally certain that the number of minute forms is much too small in the *Galathea* trawl; this is true of all the groups of smaller crustaceans (especially amphipods), and of gastropods and bivalves.

All things considered, it cannot be denied that a close study of Table 1 gives rise to no little surprise. Why did the *Vema* take so many of the sedentary polyp *Stephanoscyphus,* but only a single specimen of the equally sedentary, stalked barnacle *(Scalpellum)* while the *Galathea* took 32 of the latter? Why should St. 716 be especially poor in amphipods which are otherwise – also in other *Galathea* trawlings – amongst the most frequently occurring abyssal animals? Most of the echinoderms from St. 716 are fairly large specimens (5-15 cm); yet we obtained many small, juvenile stages of the various echinoderm groups too. Considering the fact that more than half of the animals taken at St. 716 are echinoderms (only the number of polychaete worms is equal to the average number of the groups sea-cucumbers, brittle-stars, sea-stars and sea-urchins), it is very surprising that they play such an unimportant role in the *Vema* hauls.

The total absence of certain forms is also striking. Why did the *Vema* take no gephyreans, while other partly or completely buried animals like polychaetes, cumaceans, solenogastres and bivalves are well represented? Where are the flatworms, ostracods, bryozoans, and pogonophores in the *Galathea* collection? As to the two former groups, they may be so small in size that they passed right through the sieve. Concerning the bryozoans obtained by the *Vema,* it has not been stated whether they were growing in colonies on a substratum or whether they occurred more or less singly; in the latter event they are likely to be very small forms. But the pogonophores live in tubes which are of a considerable length and easy to recognize. *Vema*'s three pogonophores may be identical either with a species taken by the *Vitjaz* off the west coast of North America and recently described by Ivanov (1961), having a tube 30-45 cm long, or with one of the two species taken by the *Galathea* in the Gulf of Panama; one had a tube 15 cm long while the other a tube 3-7 cm long (Kirkegaard 1956b).

As an explanation it might be assumed that the animals are not randomly dispersed. It is known that this is true of certain animals like cumaceans and ophiuroids, but in this case it surely cannot be of importance. The table in Menzies *et al.* (1959) not only gives the total number of individuals of the various animal groups, but also the number for each of the eleven hauls. A comparison shows that in all the more abundantly occurring groups the number of individuals varies amazingly little from haul to haul.

Whatever may be the reasons for the marked disagreement in the relative number of individuals it is very clearly shown that one cannot afford to draw too far-reaching conclusions from a single or a few hauls (or bottom samples) at a given locality – however rich in species and individuals they may be. Even in relatively well-explored areas of the deep-sea we may come across similarly surprising facts. Our knowledge of the fauna of the abyssal depths is still exceedingly poor.

GENERAL DISTRIBUTION

Of the 132 species occurring at St. 716, a total of 65 have, up to the present, been identified with sufficient certainty to be considered in a survey of the general distribution of the species found at this station. Sixteen of these 65 species were described recently or are under description (1 sponge, 2 sea-anemones, 8 crustaceans, 3 molluscs, and 2 holothurians), but it is as yet too early to state whether 10 of these new species were taken exclusively at St. 716 or whether they also occur at other *Galathea* stations. These 10 species have, therefore, not been included in the present survey. The remaining 6 new species (which are all crustaceans) are known from St. 716 only and are entered in Table 2. It should be noted that for several of the remaining 49 species in the table it is as yet not known whether they have been taken at *Galathea* stations other than St. 716. For all species, the find at St. 716 has been included in Table 2.

Regional distribution

Of the 55 species in the table, no less than 30 species and 2 subspecies are, according to our present knowledge, restricted to the East Pacific Ocean, and two more species *(Pseudostichopus mollis* and *Aërop-sis fulva)*, are almost exclusively known from this part of the Pacific. Even if 20 of these 30 species are

Table 2. Regional and bathymetrical distribution of identified species from St. 716. In most cases the total number of finds is given. The identification of the species marked (*) is not quite certain. In species marked (°) all *Galathea* finds are included. Records of subspecies not found in the East Pacific are in paranthesis.

Species	Regional distribution					Bathymetrical distribution		
	East Pacific	West Pacific	Atlantic Ocean	Indian Ocean	South Polar Sea	Bathyal	Abyssal	Hadal
Porifera								
Hyalonema bianchoratum	3	–	–	–	–	–	3	–
Cladorhiza linearis	2	–	–	–	–	–	2	–
Coelenterata								
°*Stephanoscyphus simplex*	3	18	8	11	1	12	25	4
**Edwardsia intermedia*	2	–	–	–	–	1	1	–
Bolocera pannosa	2	–	–	–	–	1	1	–
Actinoscyphia plebeia	2	–	–	–	–	1	1	–
Condrophellia coronata	2	–	8	–	–	7	3	–
**Amphianthus lactea*	2	–	–	–	–	1	1	–
Umbellula thomsoni	1	2	12	4	–	2	17	–
Vermes"								
**Travisia profundi*	2	4	1	–	–	1	3	3
°*Priapulus abyssorum*	2	–	–	–	–	–	2	–
Crustacea								
°*Neotanais armiger*	2	–	–	–	–	–	2	–
°*Neotanais pfaffi*	1	–	–	–	–	–	1	–
°*Ischnomesus roseus*	2	–	–	–	–	–	2	–
°*Ischnomesus planus*	1	–	–	–	–	–	1	–
°*Paropsurus giganteus*	1	1	–	–	–	–	2	–
°*Storthyngura pulchra*	4	(1)	(1)	–	–	(1)	4	(1)
°*Munnopsis longiremis*	2	–	–	–	–	1	1	–
°*Parargissa galatheae*	1	–	–	(1)	–	–	2	–
°*Haploops lodo*	1	–	–	–	–	–	1	–
°*Leucothoe panpulco*	1	–	–	–	–	–	1	–
°*Probeebei mirabilis*	2	–	–	–	–	1	1	–
Pycnogonida								
°*Colossendeis colossea*	×	×	×	×	?	×	×	–
°*Colossendeis cucurbita*	2	3	2	–	–	–	7	–
°*Colossendeis macerrima*	×	×	×	×	?	×	×	–
Mollusca								
°*Neopilina galatheae*	4	–	–	–	–	1	3	–
Dentalium megathyris	13	–	–	–	–	4	9	–
Tractolira sparta	5	–	–	–	–	–	5	–
**Pleurotomella agonia*	3	–	–	–	–	2	1	–
Limopsis compressus	9	–	–	–	–	–	9	–
**Chaetoderma californicum*	2	–	–	–	–	1	1	–
Echinoderma								
°*Oneirophanta mutabilis*	12	5	5	5	2	1	28	–
°*Benthodytes typica*	2	6	19	12	–	2	35	2
°*Benthodytes incerta*	3	–	–	–	–	–	3	–
°*Psychropotes longicauda*	2	2	–	–	3	–	7	–
°*Synallactes aenigma*	6	1	–	–	–	–	7	–
°*Pseudostichopus mollis*	23	–	–	1	3	17	10	–
°*Staurocucumis abyssorum*	24	3	4	1	4	5	31	–
°*Sphaerothuria bitentaculata*	14	20	5	16	–	36	19	–
°*Molpadia musculus*	×	×	×	×	–	×	×	–
°*Molpadia granulata*	4	–	–	–	–	–	4	–
°*Protankyra brychia*	5	5	16	4	–	3	27	–
°*Dytaster gilberti*	*c.* 16	–	–	–	–	–	*c.* 16	–
°*Eremicaster gracilis*	18	4	–	–	–	–	22	–
*"*Mediaster*" *elegans*	3	–	–	–	–	1	2	–
Ophiura irrorata	several	some	several	several	some	*c.* 6	*c.* 20	–
Ophiernus vallincola	*c.* 6	*c.* 5	*c.* 10	–	–	8	*c.* 13	–

Table 2 (cont.)

Ophiosphalma glabrum	*c.* 35	–	–	–	–	5	*c.* 30	–
**Amphiura serpentina*	*c.* 9	–	–	–	–	*c.* 8	1	–
Ophiacantha cosmica	*c.* 6	*c.* 2	*c.* 10	*c.* 7	–	1	*c.* 24	–
Aporocidaris milleri	6	–	–	–	–	–	6	
Urechinus loveni	*c.* 10	–	–	–	–	–	*c.* 10	–
Aëropsis fulva	*c.* 10	1	–	–	–	1	*c.* 10	–
Ascidiacea								
°*Dicarpa simplex*	1	1	1	–	–	–	3	–
Pisces								
°*Galatheathauma axeli*	1	–	–	–	–	–	1	–
Total number of finds[1]	*c.* 295	*c.* 83+1	*c.* 101+1	*c.* 61+1	13	*c.* 130+1	*c.* 441	9+1

[1] Exclusive of four cosmopolitan species in the regional distribution and of three in the bathymetrical.

known from only three localities or fewer, it is, nevertheless, a remarkably high number and is in strong opposition to that claimed by Ekman (1953, p. 292). This author could find no indication of a special fauna element in the deeper part of the East Pacific corresponding to that existing in the littoral and sublittoral zone. Moreover, it seems likely that most of the 10 new species, mentioned above and not included in the table, will also prove to be restricted to the East Pacific Ocean.

Ekman used the 1000 m line as the limit between the bathyal and abyssal faunas, and according to this definition practically all 30 species are exclusively abyssal. If the limit is placed at the more generally accepted depth of 2000 m, 11 of the 20 East Pacific species known from at most three finds are abyssal, while the remaining 9 are both bathyal and abyssal; of the 10 species from more than three finds, six are abyssal, a further three are abyssal but with a few finds from bathyal depths, while one *(Amphiura serpentina*, the identification of which is not quite certain), is almost exclusively bathyal.

The, apparently considerable, number of endemic abyssal species in the East Pacific, (and to a much minor extent the Central, Pacific which is, however, very poorly known) supports the suggestion put forward by Madsen (1961 b, p. 210) of a special East (and Central) Pacific fauna element.

The number of cosmopolitan species is also considerable. Of the 55 species considered, 12 occur in all three oceans and at least three of these also in the South Polar Sea. Moreover, *Psychropotes longicauda* has been recorded from the Pacific Ocean and the South Polar Sea south of the Indian and Atlantic Oceans. According to Mr. Bent Hansen (verbal communication), his unpublished data show that this species is also typically cosmopolitan. When the Indian Ocean becomes better known the four Pacific-Atlantic species *(Travisia profundi, Colossendeis cucurbita, Ophiernus vallincola,* and *Dicarpa simplex)* will probably prove to be cosmopolitan too.

Bathymetrical distribution

Of the 55 species, no less than 24 are exclusively abyssal, having been taken only between depths of 2000 to 6000 m and below 4° C. Ten of these 24 species have been recorded from at least four localities.

Three species have a wide bathymetrical distribution, ranging from bathyal to hadal depths but are primarily abyssal (one even with separate subspecies in the hadal and the bathyal zones). A fourth species with a similarly wide vertical distribution, has been found only once in the bathyal zone.

Of the 23 bathyal-abyssal species, 10 are so far known from only 1-4 finds each, while the remaining 13 have been taken 9-55 times each. Eight of the latter species are primarily abyssal, more than 75 per cent of the finds having been made at depths greater than 2000 m. The average abyssal percentage of these eight species taken together is even as high as 89 and, in addition, many of the finds from depths of less than 2000 m were made at temperatures below 4° C.

Thus, a total of 36 of the 55 species are almost exclusively abyssal and 22 of them have been recorded from at least four localities.

Finally, three species *(Chondrophellia coronata, Pseudostichopus mollis,* and *Sphaerothuria bitentaculata)* are primarily bathyal, having been taken about twice as many times in this zone as in the abyssal. One species *(Amphiura serpentina)* is, as mentioned above, almost exclusively bathyal; the identification of this species is, however, somewhat doubtful.

SUMMARY

1. Apart from JOHN MURRAY's comprehensive lists of the names of all species and of the number of specimens collected at each of the *Challenger* Expedition stations (1895), accounts of the animal assemblage found in abyssal trawlings of other deep-sea expeditions are very few and far between. The present paper deals with the species dredged at *Galathea* St. 716 at a depth of 3570 m in the East Pacific off Costa Rica. This extremely rich trawl yielded no less than 132 different species and about 2100 specimens of benthic metazoans. The trawling operation is described in detail and information on the environment provided.

2. A description of all the more noteworthy species is given. Facts or suggestions on the biology or behaviour of several of them are discussed, sometimes by referring to what is already known about related shallow water species. The regional and bathymetrical distribution of species previously described from other sources is recorded, as is the majority of the genera represented at St. 716. The tracks shown on a deep-sea photograph, published by MENZIES *et al.* (1959) and identified as *Neopilina* tracks, are discussed and the argument put forward that they might instead originate from bivalves. The estimates on population density, based on trawlings and deep-sea photographs (1. c.) are discussed and criticized. In view of a recent bathyal find of *Neopilina* it is suggested that it may have descended into the abyssal zone fairly recently. It is shown that the amphipod *Parargissa galatheae* must be considered benthic due to the stomach content being composed of i. a. woody debris.

3. A comparison between the number of species and individuals of various animal groups at St. 716 is presented in Table 1, which also gives the number of individuals obtained from a total of 11 trawlings carried out by the *Vema* Expedition in the same area. Primarily due to differences in the size of gear used by the *Galathea* and the *Vema* (a large herring otter trawl and a 1 m dredge with a very fine meshed bag, respectively), a marked difference in the abundance of the various animal groups was found. The dominating groups at St. 716, as far as the number of individuals is concerned, are holothurians, ophiuroids, polychaetes, asteroids, and echinoids while in the *Vema* trawlings polychaetes, bivalves, amphipods, tanaids, and isopods proved to predominate. There were also, however, several inconsistencies which can hardly be ascribed to the different collecting techniques. Nor can they, in this case, be satisfactorily explained by the animals in question having a patchy distribution, since the contents of the eleven *Vema* trawlings are remarkably uniform. The obvious disagreement in the relative number of individuals obtained by the two expeditions suggests that one should not draw too far-reaching conclusions from a single or a few hauls in the deep-sea.

4. The general distribution of 55 identified species is given in Table 2. No less than 30 species and 2 subspecies are restricted to the East Pacific (10 of the species and 1 subspecies are known from at least four localities); two more commonly recorded species are almost exclusively from the East Pacific. More than half of the East Pacific species are restricted to the abyssal zone. Thirteen species are cosmopolitan and another four, which have not yet been taken in the Indian Ocean, will probably also prove to be distributed in all three oceans.

Of the 55 species, 24 are exclusively abyssal (from depths exceeding 2000 m and temperatures below 4° C.), and 10 of these are recorded from at least four localities. Three of the four species with a wide bathymetrical distribution from the bathyal to the hadal zone are primarily abyssal, and this is also the case with eight of the more commonly found bathyal-abyssal species. Only four species are primarily bathyal.

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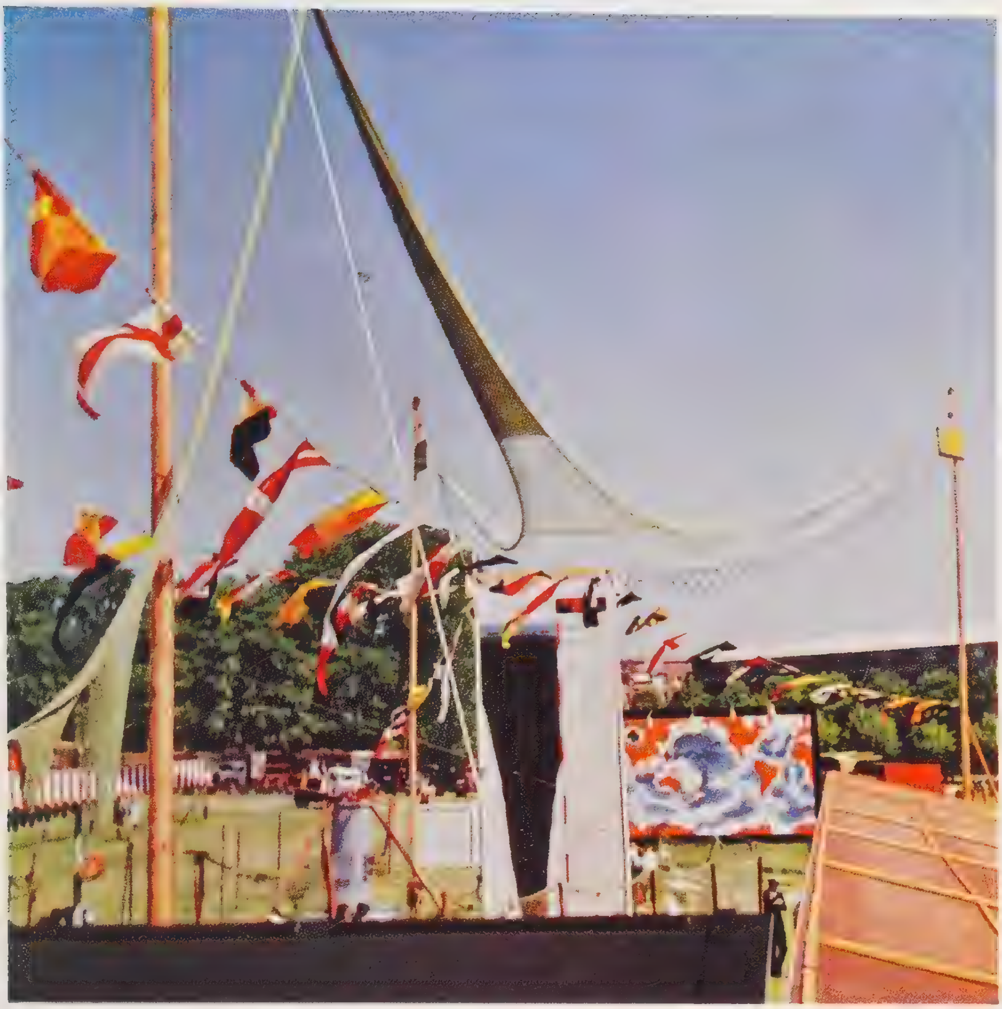


Fig. A. A suspended herring otter trawl; width at mouth 30 m, length 60 m. The 1.5 m broad otter boards are hoisted up the two masts in the background. From an exhibit in Copenhagen after the return of the *Galathea*. (PETER RASMUSSEN phot.).

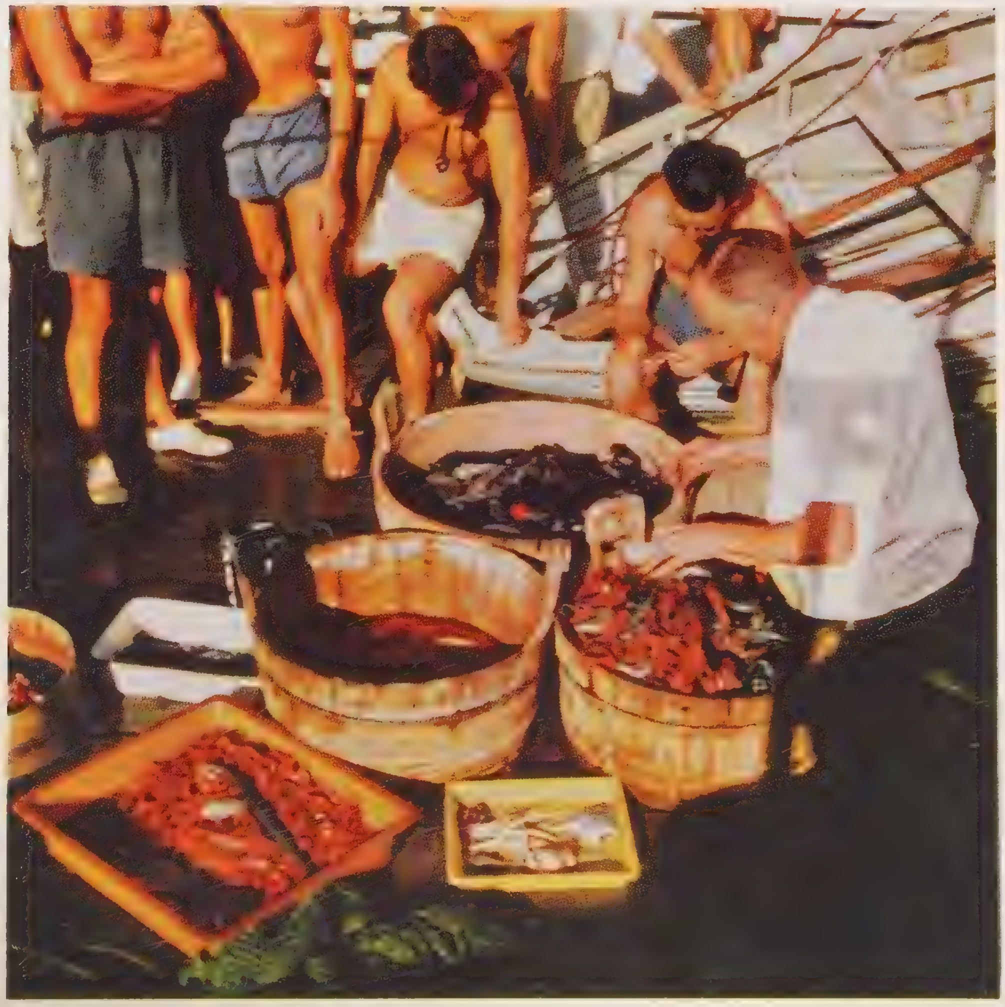


Fig. B. In the Gulf of Panama, about 700 km S.E. of St. 716, another very rich trawling (St. 739) was carried through at 915-975 m depth; it contained about 60 species and about 1665 specimens of mainly larger, benthic animals. The photograph shows the first sorting; in the foreground trays with red shrimps and large white sea-anemones, behind, tubs with red shrimps and black fish. (MOGENS HØYER phot.).

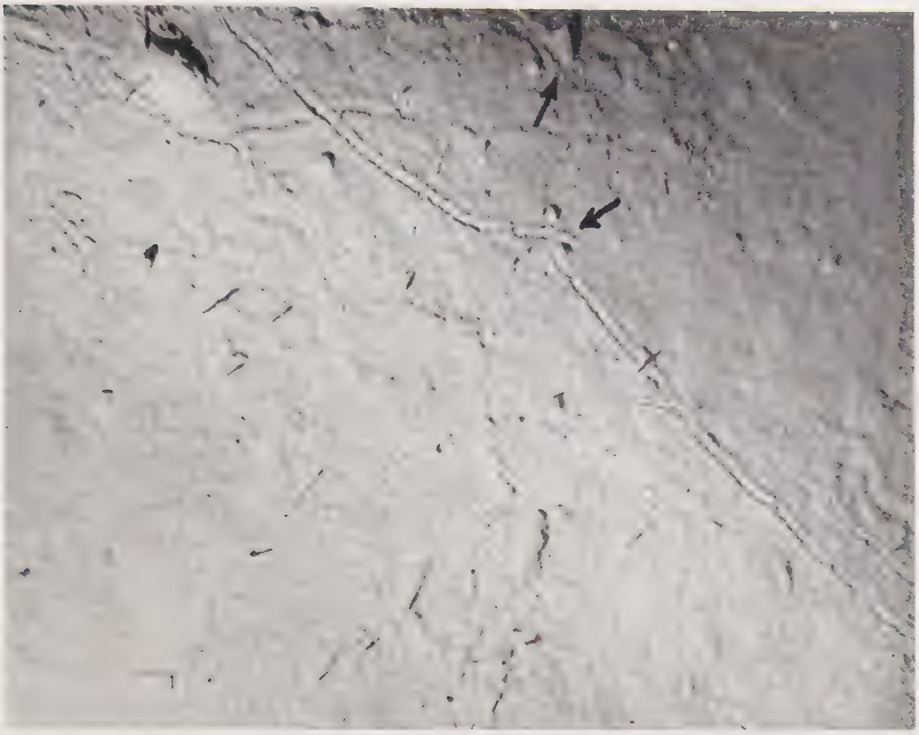


Fig. A. Photograph of the Peru-Chile Trench floor (*Vema* 15. St. 150: 7°35′ S, 81°24′ W, 5820-5840 m). Two tracks of ?bivalves (cf. the text p. 134), sea-pens, and probably a holothurian in upper left corner. (After MENZIES *et al.* 1959).

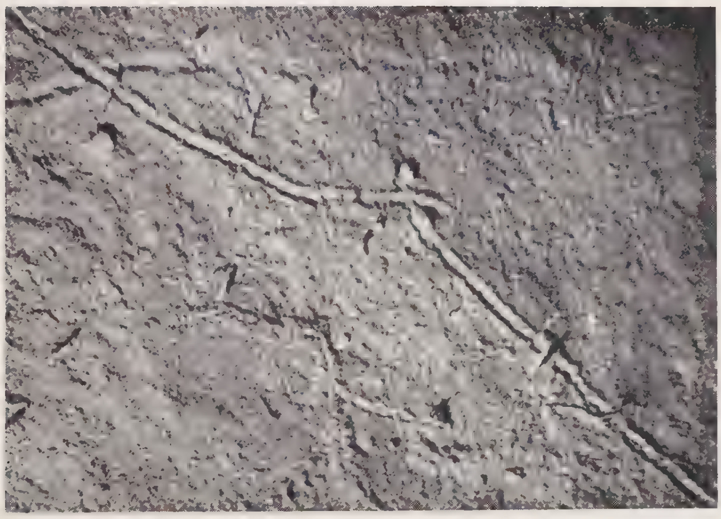


Fig. B. Magnified reproduction of part of the tracks on Fig. A. (After MENZIES *et al.* 1959).

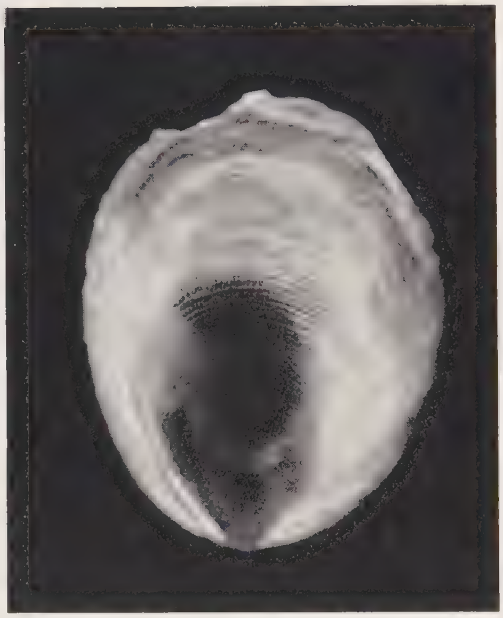


Fig. D. Dorsal view of *Neopilina (Vema) ewingi*. (After MENZIES *et al.* 1959).

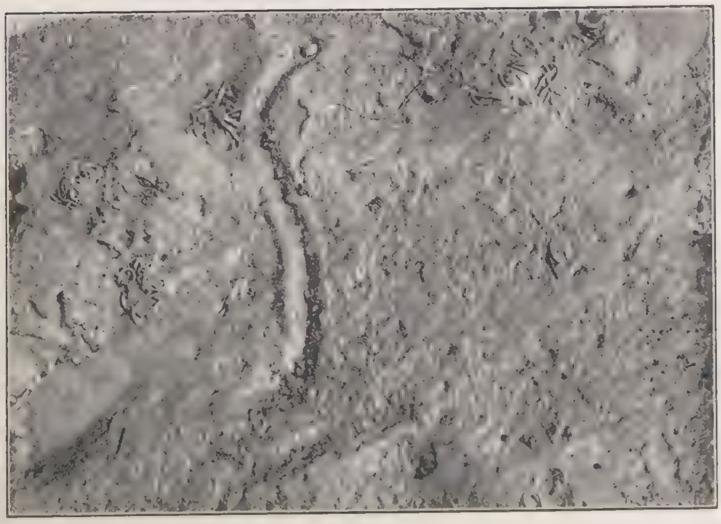


Fig. C. Groove-shaped track of *Cardium* in the Danish Wadden Sea; animal visible at the upper end. (After THAMDRUP 1935).

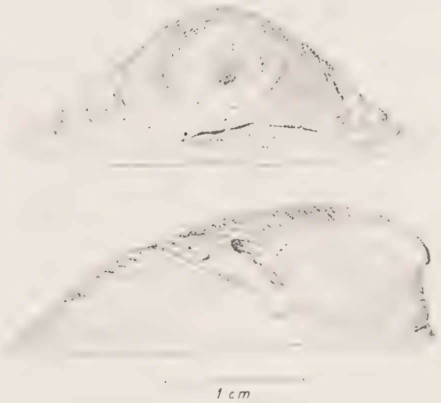
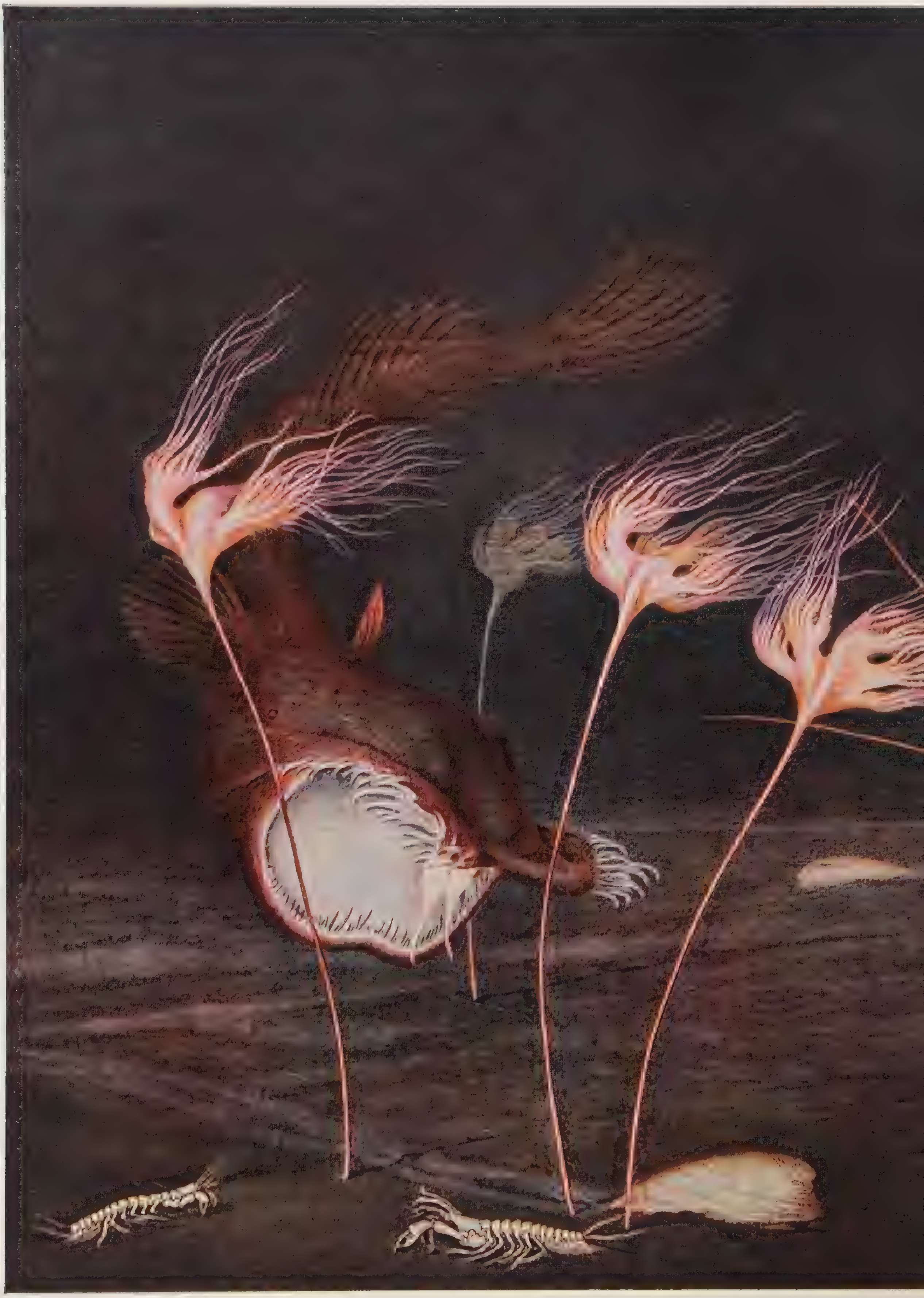
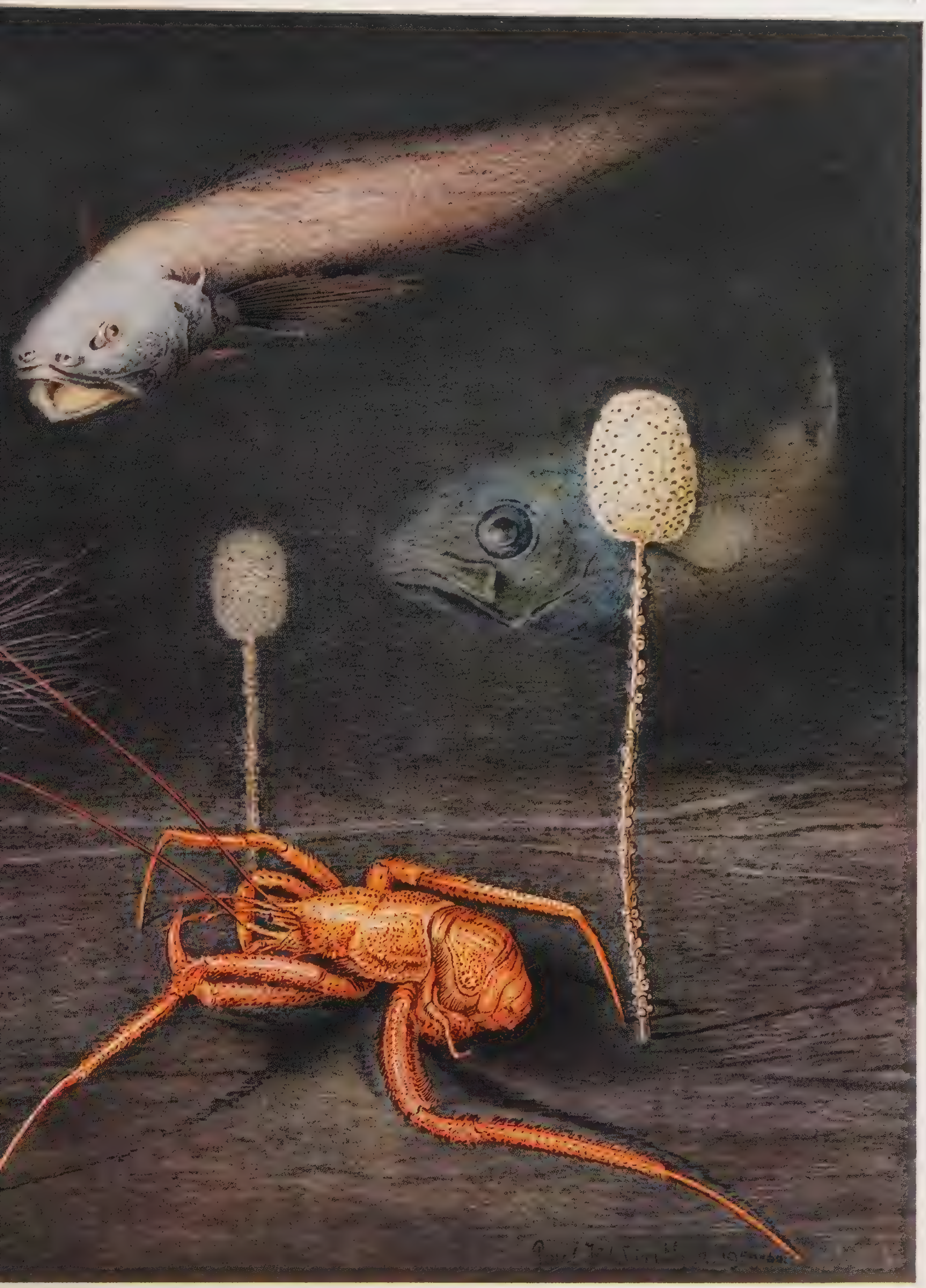


Fig. E. Anterior and lateral view of *Neopilina galatheae*. (After LEMCHE & WINGSTRAND 1959).



On the left half is the deep-sea angler fish *Galatheathauma axeli*, a cluster of sea-pens *(Umbellula thomsoni)*, two creeping *Neopilina galatheae* and a female (left) and male of the tanaid species *Neotanais pfaffi*. – At the top of the right half is a brotulid of the genus *Bassogigas*, in the background a large alepo-

PLATE IX



cephalid fish; two silicious sponges *(Hyalonema)* with colonies of the sea-anemone *Epizoanthus* on the stalk and the reddish hermit crab *Probeebei mirabilis* with armoured abdomen. The animals in the extreme foreground are a little more than nat. size, all others more or less reduced. (Cf. the text pp. 132-138).

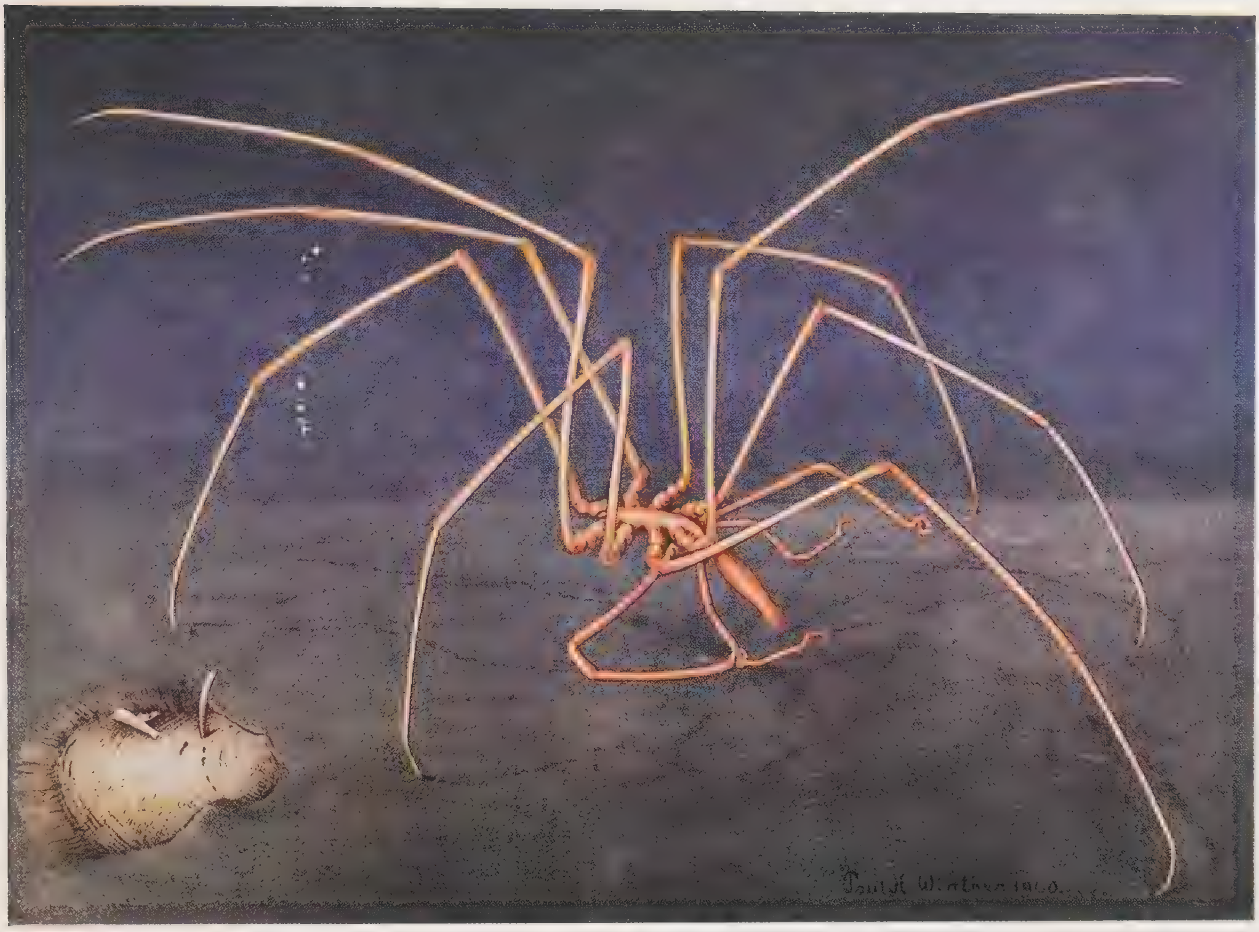

Poul H. Winther 1960.

Fig. A. The stilt-legged sea-spider *Colossendeis colossea* walking slowly and cleaning the right palp with the right oviger. To the left a partly buried bivalve *Limopsis compressus* with a serpulid worm and the polyp *Stephanoscyphus simplex* on the shell. The bivalve is almost nat. size, the sea-spider about $^1/_2$ nat. size. (Cf. the text pp. 138-139).

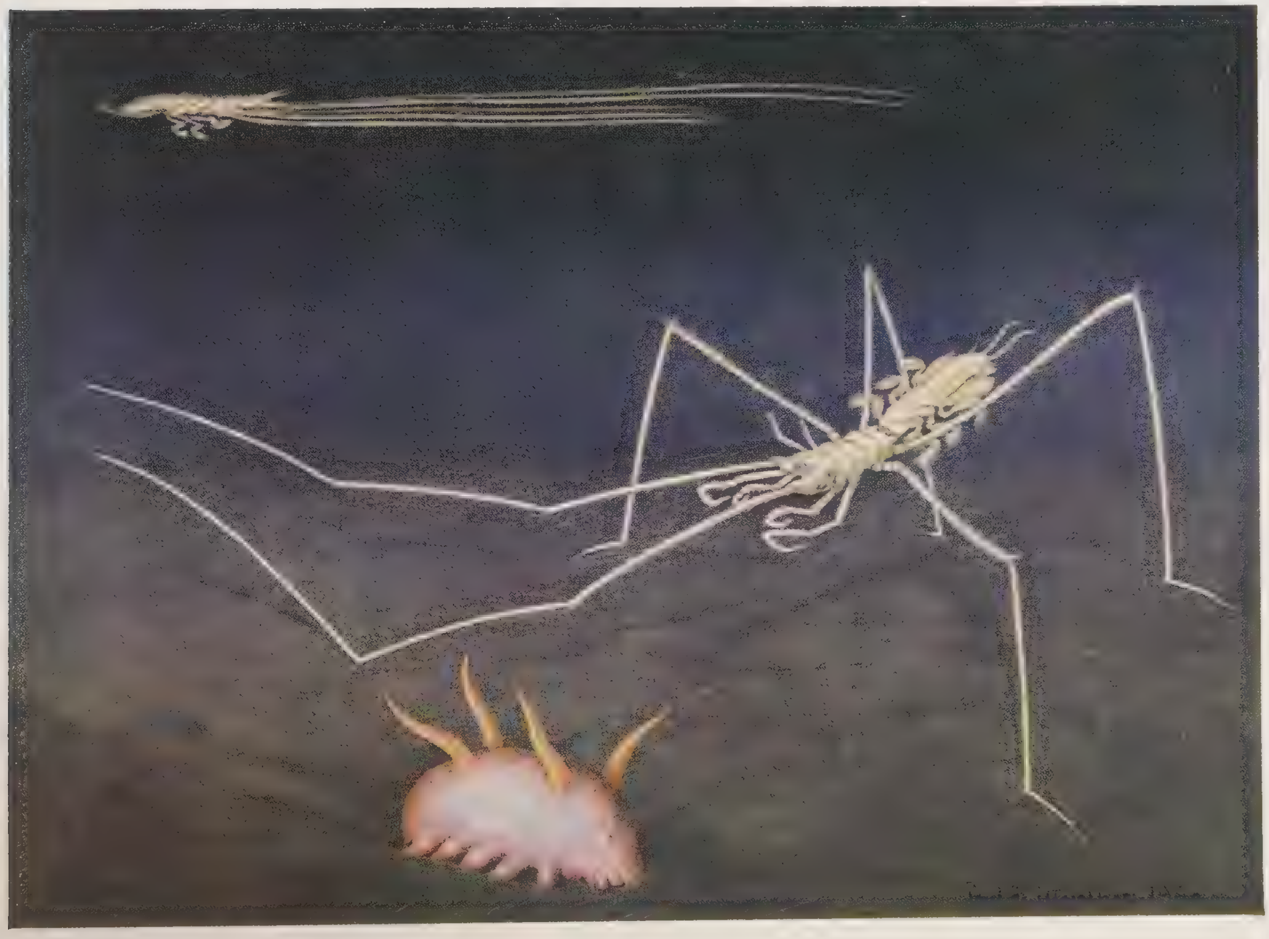


Fig. B. The isopod *Munnopsis longiremis* with the second antennae and two pairs of legs strongly elongated. In the background a backwards-swimming specimen. A small specimen of a sea-cucumber, *Scotoplanes* n. sp. in the foreground. 1.5 × nat. size. (Cf. the text pp. 139-140).

THE BATHYAL AND ABYSSAL *XYLOPHAGA*
(PHOLADIDAE, BIVALVIA)

By JØRGEN KNUDSEN
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A. INTRODUCTION

The bivalve material collected by the *Galathea* Expedition contains 17 species of the wood boring genus *Xylophaga*, all of them apparently new to science. They were all obtained at depths below 400 meters. In addition to the material collected by the *Galathea*, four previously described species have been included in the present study: *X. praestans* E. A. Smith, *X. indica* E. A. Smith, *X. tomlini* Prashad and *X.* sp. mentioned by PELSENEER (1911).

Xylophaga lives in wood and other kinds of plant debris deposited on the sea bottom; only a few species appear sometimes to live in plant material floating at the surface. During the *Galathea* Expedition plant remnants were obtained from altogether 56 stations between 400 and 10150 m depth. This material was carefully examined onboard and revealed a number of specimens of *Xylophaga*, which were preserved in 70 % alcohol. Practically all the plant material dredged during the expedition was preserved dry and subsequently examined by the present author. This resulted in a considerable number of specimens being found. Although the soft parts had already dried up prior to examination, the shells, including the accessory plates, were in most cases, in very good condition.

It might seem astonishing that the *Galathea* collection contained such a large number of species of *Xylophaga*, that the number of known species is more than doubled. This is certainly not because of undue "splitting" since the specific differences found in the present material are as distinct as those found in the previously described species. It is believed that the relatively large number of new species is simply due to the special attention which, during the expedition, was paid to organisms found in plant debris. No doubt future expeditions could add still more species, if the plant debris is carefully examined.

Acknowledgments: The author is greatly indebted to Mr. I. C. J. GALBRAITH, British Museum

(Nat. Hist.) for the opportunity of studying the types of *X. indica* E. A. Smith and *X. praestans* E. A. Smith. To Mrs. T. van der Feen, Zoologisch Museum, Amsterdam, for the loan of the type of *X. tomlini* Prashad and to the directors of the Zoological Museums at Trondheim and Bergen (Norway) for making available their valuable collections of *Xylophaga* for the purpose of study. Dr. Ruth Turner has given valuable suggestions and sent drawings of paratypes of three species of *Xylophaga* described by Taki and Habe (1945, 1950). Mr. T. Betchaku very kindly translated into English the Japanese paper by Taki & Habe (1945). Mr. P. H. Winther, the artist, drew the figures marked "PHW" with his usual care and skill. The remaining figures were drawn by the author. The English text has been revised by Mrs. M. Goodfellow. Finally, I wish to thank my colleagues, A. F. Bruun D. Sc. and T. Wolff Ph. D. for valuable discussions and suggestions during the preparation of the present report.

The bulk of the *Galathea* material, including all the types, is kept in the Zoological Museum of the University, Copenhagen. A set of duplicates has been handed over to the Museum of Comparative Zoology Harvard University, Cambridge, Mass. U.S.A. The specimens' measurements are given in millimeters.

B. REMARKS ON THE SHELL MORPHOLOGY

(Fig. 1)

The shell is more or less globular and widely open anteriorly; the antero-dorsal part is distinctly marked off from the rest and is termed the beak. Seen from the dorsal side there is an interspace between the two beaks, the anterior incision. The edges of the latter may be erect or reflected, sometimes adhering to the underlying parts of the beak; in some species the edge forms a posterior lobe, covering part of the umbo. The edge of the anterior incision is here termed the umbonal reflection. In *Xylophaga* the accessory plate, in accordance with (Turner 1955), is termed the mesoplax but the term protoplax is used by a number of previous authors. The mesoplax consists of two plates inserted on the umbonal reflection. In some species it occupies the anterior incision completely, but in others, only part of it. The most simple form of the mesoplax is a triangular plate with the two parts situated in a horizontal position. The edges inserted on to the umbonal reflection are termed the basal edges, the edge where the two plates of the mesoplax meet the median edge and the third edge the anterior edge. The mesoplax has, however, been subjected to considerable modification (Fig. 1e-i.). In a number of species the median part is so raised, that in frontal view the two plates form an angle. In some species the individual plates are longitudinally curved, and other species have the lateral parts sharply bent. Finally, some species have a semicircular or fan-shaped mesoplax in a vertical position, forming a dorsal anterior edge.

The shell is divided in two by the umbonal-ventral sulcus extending from the umbo to the ventral edge of the shell. The anterior part of the shell consists of the beak and the anterior slope. The beak has numerous distinct ridges running parallel to its ventral edge which continue on the anterior slope as oblique ridges. The inside of the shell shows a rather distinct posterior muscular impression which has a distinct transverse or radiating sculpture in many species. Corresponding to the umbonal-ventral sulcus, the interior shows a prominent, articulated umbonal-ventral ridge, having in most species, a distinct ventral condyle.

C. A SHORT ACCOUNT OF THE HITHERTO DESCRIBED SPECIES OF XYLOPHAGA

(1) Turton (1819) described *Teredo dorsalis* which he himself, in 1822, transferred to a separate genus *Xylophaga*. *X. dorsalis* is a common littoral species of the N. E. Atlantic. (2) Sowerby (1835) described *X. globosa* from shallow water off Valparaiso, Chile. (3) Dall (1886) described *X. abyssorum* known from shells only, in the W. Atlantic from off the coast of New Jersey to the Lesser Antilles. (4) *X. praestans* was described by E. A. Smith (1903) from off the N. E. coast of England in shallow water. (5) *X. indica* was described also by E. A. Smith (1904) from the N. part of the Indian Ocean. (6) Dall (1908) described

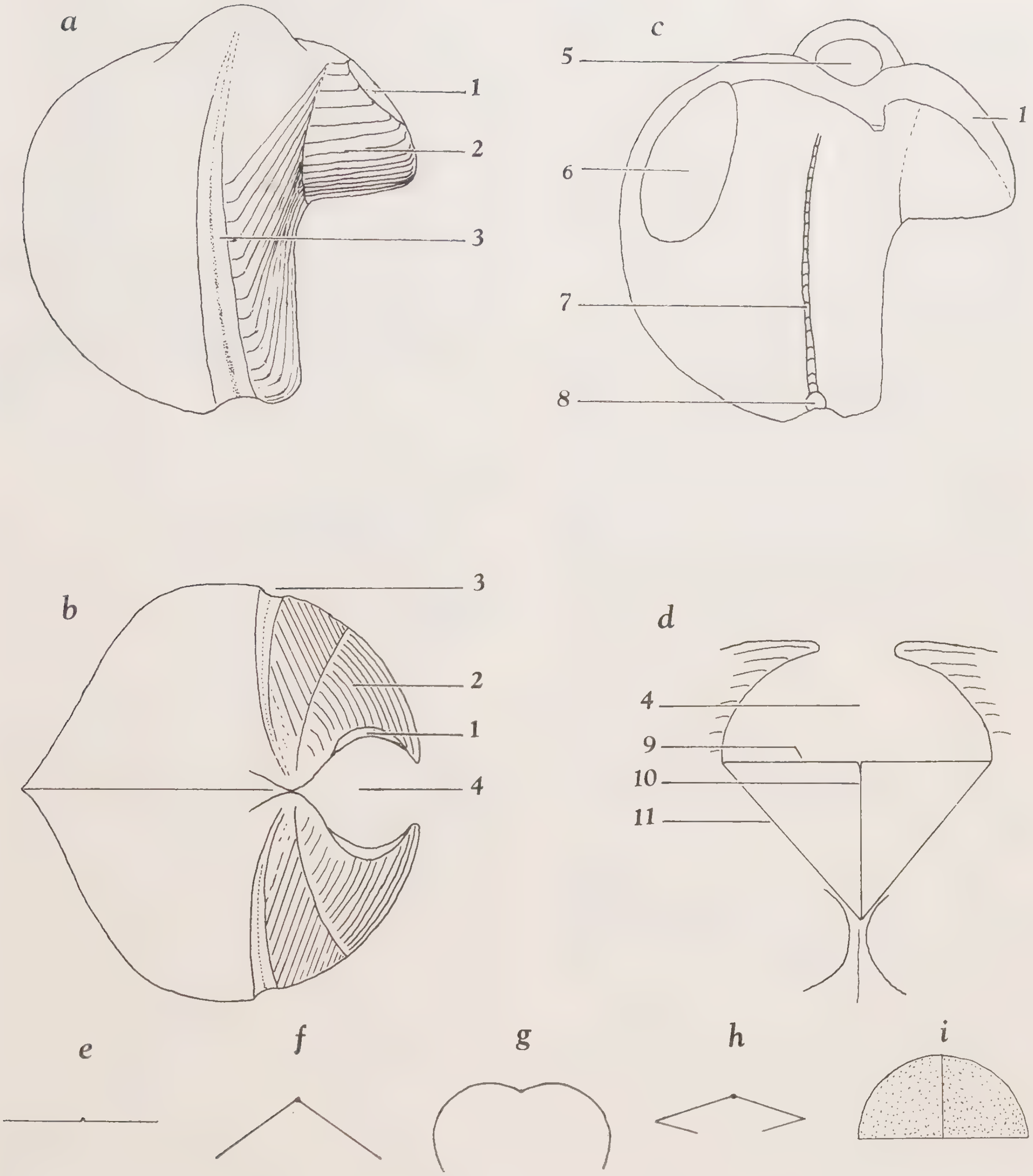


Fig. 1. Diagrams of the shell of *Xylophaga;* a, lateral view; b, dorsal view; c, internal side of shell; d, dorsal view of anterior incision and mesoplax; e-i, frontal view of different types of mesoplax. 1, umbonal reflection; 2, beak; 3, umbonal-ventral sulcus; 4, anterior incision; 5, prodissoconch; 6, posterior muscular impression; 7, umbonal-ventral ridge; 8, condyle; 9, anterior edge; 10, median edge; 11, basal edge.

X. mexicana from off Acapulco, the Pacific coast of Mexico. The species was based on a single valve and was not figured. – Bartsch (1921) described two species both from the Pacific coast of N. America and both from shallow water, viz. (7) *X. washingtona* and (8) *X. californica*. Prashad (1932) added (9) *X. tomlini* from the Indo-Malayan waters. – (10) *X. atlantica* was described by Richards (1942). Taki & Habe (1945) described (11) *X. rikuzenica* from the Japanese waters, off Rikuzen – and finally, Taki & Habe (1950) added three species also from Japanese waters. One of these (12) *Xylophaga japonica* comes from Tosa Bay. The two other species were put in separate new genera (13) *Neoxylophaga teramachi*, Tosa Bay, Shikiku, and (14) *Metaxylophaga supplicata* from the same locality.

Turner (1955), showed that the two species, described by Bartsch (1921): *X. washingtona* and *X. californica* are in actual fact only one species for which the name *X. washingtona* is suggested. Thus it would appear that up to the present time 13 species of *Xylophaga* (incl. *Neoxylophaga* and *Metaxylophaga*) are known.

Finally, it should be mentioned that *Xylophaga cardissa* described by Gould (1862) is actually not a *Xylophaga* at all (Smith, 1903).

Only a few species of *Xylophaga* have been studied in some detail. Some of the papers dealing with one or several species of *Xylophaga* should be briefly mentioned: Pelseneer (1911) described and figured the gross anatomy of an unnamed species of *Xylophaga*. Lamy (1925) listed the species known until then, adding a few comments on them. Purchon (1941) studied the anatomy and biology of *Xylophaga dorsalis* Turton in great detail, adding important contributions to the knowledge of feeding habits and reproduction of the species. Turner's comprehensive paper on the Pholadidae of the Western Atlantic and the Eastern Pacific (1955) contains a very thorough study of the species of *Xylophaga* of the regions, accompanied by excellent figures. The following species were dealt with: *dorsalis* (Turton), *globosa* Sowerby, *mexicana* Dall, *atlantica* Richards, *washingtona* Bartsch and *abyssorum* Dall. The mesoplax of *dorsalis, globosa, atlantica* and *washingtona* are figured, as are the siphons of *globosa* and *atlantica*. In a short paper, Turner (1956) deals with the importance of the mesoplax and siphon in dividing up the genus *Xylophaga* into several subgenera, taking into consideration not only the species studied in her 1955-paper, but also the species described by Taki & Habe (1945, 1950).

In subsequent sections of the present survey the results of these papers will be dealt with in more detail, and in addition, a few further papers considered.

D. SYSTEMATIC PART.

Xylophaga erecta n. sp.

(Fig. 2, 3)

Material:

St. 444, Sulu Sea (7°54'N, 121°30'E), 5050 m, 17. Aug. 1951. Gear: HOT. Bottom: mud. Bottom temperature: 10.6° C. – 16 complete specimens, 4 pairs of shells with the mesoplax in situ and about 25 separate shells.

Diagnosis:

Xylophaga with a vertical mesoplax consisting of two flat plates. Siphon long and slender. The openings close together and without tentacles.

Description:

The shell is whitish, thin and semi-transparent. The beak comparatively large, extending to about half the total height of the shell. The postumbonal part of the shell forms an approximate semi-circle. It extends nearly to the topmost part of the umbo and is laterally compressed, so that when seen from the dorsal side, the posterior part of the shell is slightly concave in profile. The umbonal reflection is comparatively small and is united with the underlying parts of the shell. The anterior incision is about $^1/_3$ of the total breadth of the shell. Sculpture: The ridges of the beak are separated by interstices which are about twice the breadth of the ridges, becoming somewhat more narrow towards the ventral edge of the beak. The dorso-ventral sulcus is only faintly developed and the posterior part of the shell has a rather coarse concentric sculpture, giving the shell a somewhat foliated appearance. The interior of the shell: The posterior muscular impression is narrow and curved, extending from the dorsal edge more than half the distance to the ventral edge of the shell. The ventral part of the muscular impression has a rather distinct transverse sculpture. Anterior to the muscular impression is a distinct ridge extending from the umbo less than half the distance to the ventral edge of the shell. The umbonal-ventral ridge is rather faintly developed and distinctly articulated. A distinct rounded condyle is present ventrally.

Mesoplax vertical. The median edge is short, the anterior edge convex and the basal edge concave. The angles of the plates are rounded and there is some variation in their shape as shown in fig. 3b-c. The ventral (anterior) surface of the mesoplax is covered by a lobe of the mantle. The mesoplax has a fine concentric sculpture and in the present material small differences in its position are notice-

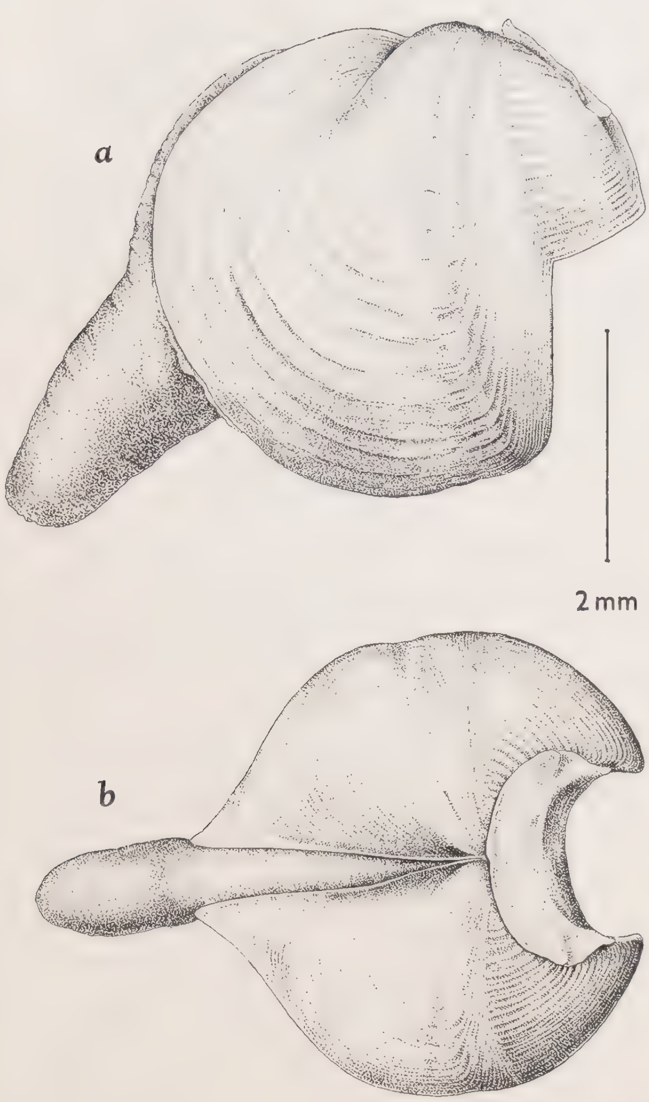


Fig. 2. *Xylophaga erecta* n. sp., holotype; a, lateral view; b, dorsal view. P. H. W.

able. In some specimens it is strictly vertical while in others it is recurved, covering the anterior part of the umbo. This may indicate that a certain movement of the mesoplax is possible.

Siphon long and slender. In some specimens projecting about twice the length of the shell. The two openings are placed close together at the tip, and no surrounding cirri are visible. In nearly all specimens the mantle more or less projects from the dorsal and posterior edge of the shell.

Dimensions of the type specimen:
Length: 4.3; height: 4.1; breadth: 4.2
Reproduction: nothing known.
Affinities: see p. 168.

Xylophaga concava n. sp.
(Fig. 4, 5)

Material:

St. 726, Gulf of Panama (5°49'N, 78°52'W), 3670-3270 m, 13. May 1952. Gear: HOT. Bottom: clay. Bottom temperature: about 2° C. – 4 specimens picked out from a water-logged tree trunk. St. 739, Gulf of Panama (7°22'N, 79°32'W), 915-975 m, 15. May 1952. Gear HOT. Bottom: green clay. – About 25 specimens containing the dried up soft parts and a few single shells.

The largest specimen from St. 726 has been selected as the type.

Diagnosis:

Xylophaga with a vertical semicircular, mesoplax, a slender siphon with both openings at the tip and the shell with a laterally constricted posterior part.

Description:

The shell is rather thin, semi-transparent and shiny. The umbo is low and broad with a rounded posterior edge. The beak extends less than half of the distance to the ventral edge of the shell; the ventral edge of the beak is curved and forms an obtuse angle with the anterior edge of the shell. The postumbonal part of the shell is relatively large, the postero-dorsal edge extending beyond the umbo. Seen from the dorsal side, the postumbonal part has a distinct concave outline giving the posterior part

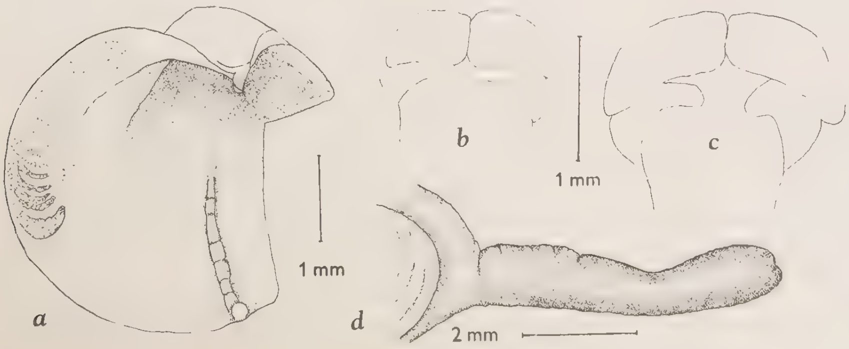


Fig. 3. *Xylophaga erecta* n. sp., paratype; a, internal side of the left valve; b and c, frontal view of the mesoplax of two specimens showing the variation in shape of plates and of the umbonal reflection; d, siphon and protuding posterior part of the mantle.

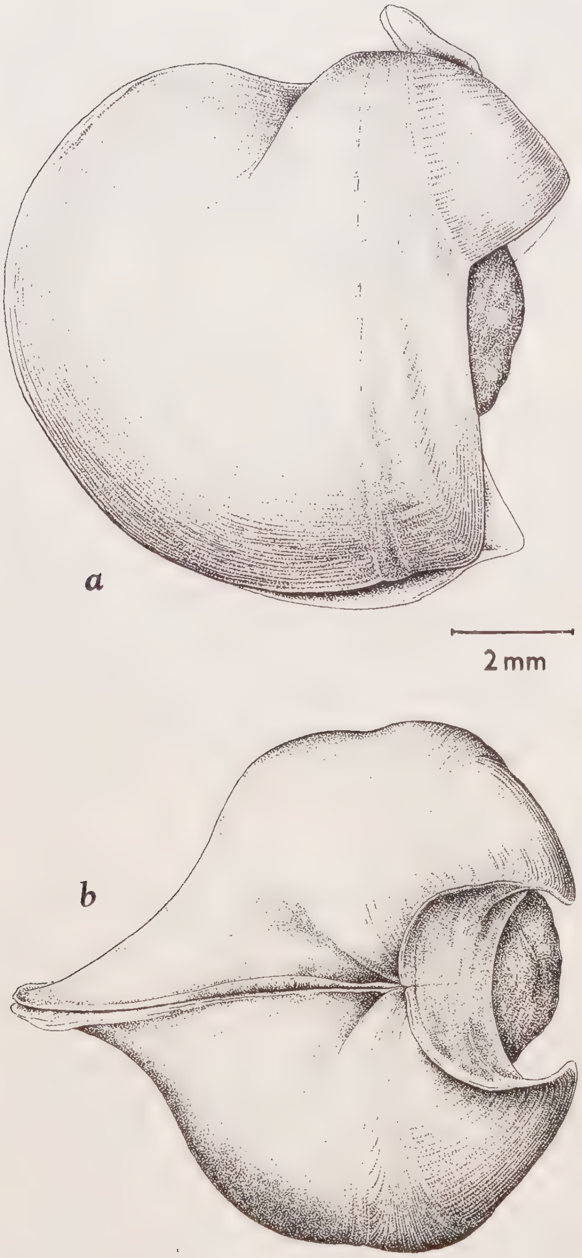


Fig. 4. *Xylophaga concava* n. sp., holotype; a, lateral view; b, dorsal view. P. H. W.

of the shell a "beak-like" appearance. The postero-dorsal edges are slightly reflected. The umbonal reflection is rather small, adhering completely to the underlying part of the beak. The anterior incision is broad, its largest breadth being a little more than $^1/_3$ of the total breadth of the shell. The beak has innumerable fine ridges which gradually become more close-set towards the ventral edge. On the dorsal part of the beak, the interstices between the ridges are about three times the breadth of a ridge, while on the ventral part, they are of approximately the same breadth as the ridges. The umbonal-ventral sulcus is a very shallow depression with a narrow central groove. Anterior and posterior to the umbonal-ventral sulcus a few rather distant and regularly spaced, concentric lines are to be seen, but apart from these and a very fine concentric striation, the shell has a very smooth appearance. Interior of the shell: The posterior muscular impression is rather indistinct, large and with a faint transverse striation. Anterior to the muscular impression there is a strong prominent, rounded edge running from the posterior part of the umbo to about half way down the shell, where it gradually becomes obsolete. The umbonal-ventral ridge is narrow, prominent and regularly segmented, condyle present.

The mesoplax consists of two plates which taken together are almost semicircular in outline, the basal edge forming the diameter. The anterior edge is posteriorly reflected and reaches beyond the umbo, which is partly covered. The mesoplax has a fine concentric striation.

Siphon present in two specimens, extending about the whole length of the shell. It is rather slender and covered with a thin and transparent periostracum. Both openings are at the distal end, close together, and around them 15-18 small cirri are present.

Dimensions of the type specimen:

Length: 8.6; height: 8.3; breadth: 8.0.

Reproduction:

A single embryo was found in the type specimen, attached to the external surface of the right side of the mantle, close to the rectum. The embryo has a shell length of about 0.9 mm; it is oval in shape and the beak and mesoplax are not developed. The central part of the shell is brown, becoming lighter towards the edge (which is hyaline), and has two brown, concentric bands. The soft parts are well preserved, showing that it is without doubt a *Xylophaga*. There is a short siphon and the foot has the characteristic appearance of a *Xylophaga*. The large size of the embryo would indicate a short pelagic life, if any at all.

Affinities:

X. concava and *erecta* differ from all hitherto known species of *Xylophaga* by the vertical position of the mesoplax. The two species are similar in a number of characters such as the low umbo, the large size of the posterior muscular impression and

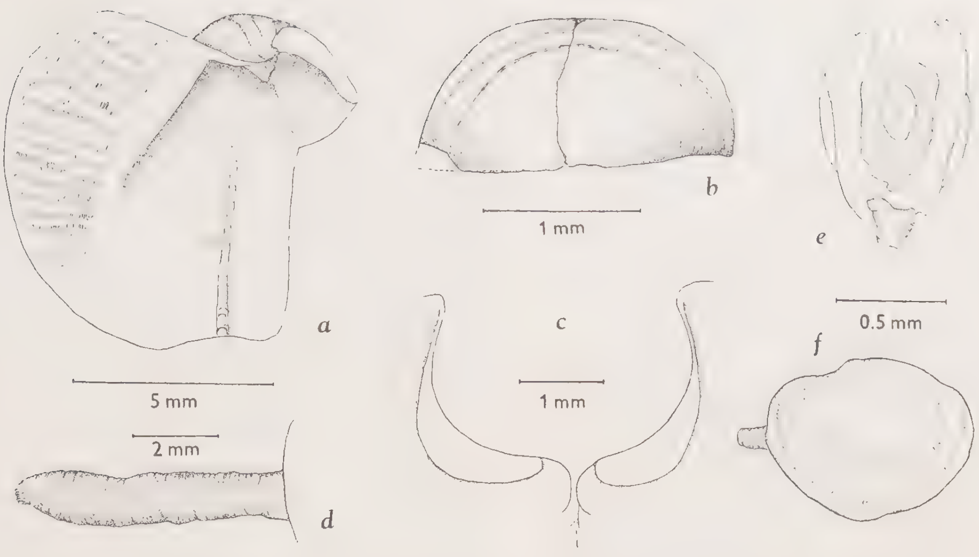


Fig. 5. *Xylophaga concava* n. sp.; a, internal side of the left valve, holotype; b, frontal view of the mesoplax, paratype; c, dorsal view of the anterior incision and the umbonal reflection, paratype; d, siphon seen from the right side, paratype; e, ventral view of an embryo; f, lateral view of the same embryo.

the rather long siphon which has both openings close together. Obvious differences are, however, present: the posterior part of the shell of *concava* is laterally compressed, giving a characteristic concave profile when the shell is seen from the dorsal side, while in *erecta* the outline of the posterior part of the shell is nearly straight. In *concava* the posterior part of the shell is rather smooth, while *erecta* has a coarsely foliated concentric sculpture. The posterior muscular impression is much broader in *concava* than *erecta*, and the sculpture of the muscular impressions differ widely in the two species. Finally, there are marked differences in the mesoplax of the two species: that of *concava* being semicircular while that of *erecta* is shaped more like a crescent.

Xylophaga lobata n. sp.

(Fig. 6, 7)

Material:

St. 444, Sulu Sea (7°54'N, 121°30'E), 5050 m, 17. Aug. 1951. Gear: HOT. Bottom: mud. Bottom temperature: 10.6° C. – About 40 specimens preserved in alcohol, 9 dried up specimens and an unknown number of specimens left in the plant debris. One of the dried up specimens has been selected as the type.

Diagnosis:

Xylophaga having a horizontal mesoplax with two frontal lobes at each side and a cylindrical siphon with both openings at the tip.

Description:

The shell is small and fragile with a low and broad umbo; the beak extending about half the distance to the ventral edge of the shell. The prodissoconch is easily visible in nearly all specimens and has a maximum length of about 0.3 mm. The umbonal reflection is well developed, triangular in shape, adhering posteriorly to the anterior part of the umbo and with its dorsal edge slightly reflected. The anterior incision has almost straight lateral edges and its maximum breadth is about one fourth of the total breadth of the shell. The ridges of the beak are widely spaced, the interstices being approximately three times as broad as the ribs on the upper part of the beak, the 4-5 ribs closest to the ventral edge being very close-set. The oblique ridges of the slope become broader and more widely spaced posteriorly. The umbonal-ventral sulcus is shallow without a central groove, and posteriorly, it is bound by a faint rounded rib. A concentric sculpture is to be seen in the region of the sulcus, gradually becoming less distinct on the posterior part of the shell. Interior of the shell: The posterior muscular impression is distinct, pear-shaped and located at some distance from the posterior edge of the shell. It has a distinct sculpture radiating from its anterior portion. The umbonal-ventral ridge is distinct, narrow and has a rounded condyle at the ventral edge.

The mesoplax consists of two triangular plates; the basal edges of each being bent. In most speci-

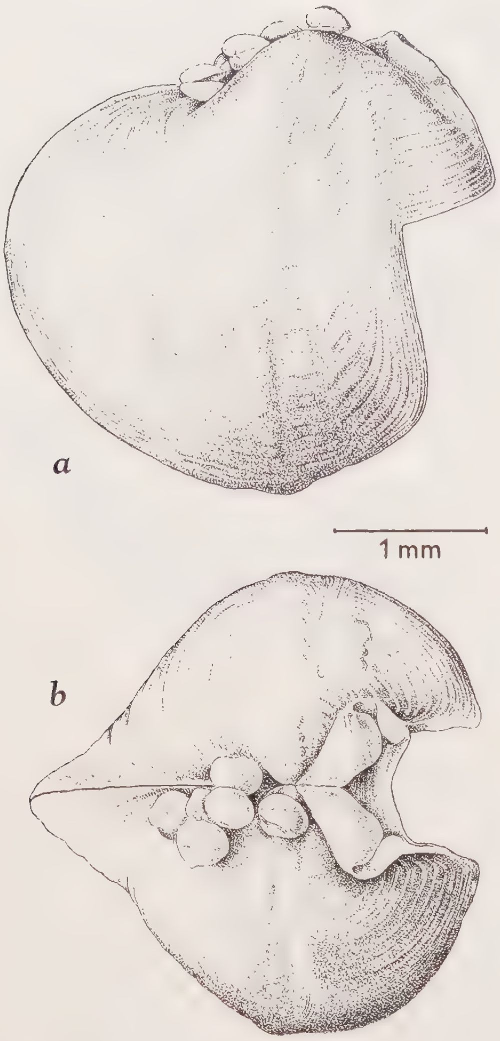


Fig. 6. *Xylophaga lobata* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

mens the anterior edge of each plate forms two lobes; the median lobes project ventrally, while the lateral ones project in a median direction. There is a considerable variation in the shape and relative size of the lobes: in some specimens the median lobe is the larger while in others the opposite is the case. Also in some specimens, the interlobal space is rather wide, while in others it is narrow, the two lobes of one plate overlapping each other. In other specimens the lateral lobe is hardly developed and the median lobe is small. The variation in the shape of the mesoplax would seem to be independent of the size of the shell.

The siphon is up to 1 mm long and cylindrical. Both openings are at the end and the incurrent opening is surrounded by a few small cirri.

Dimensions of the type specimen:

Length: 3.2; height: 3.0; breadth: 3.1.

Reproduction:

Nearly all the specimens studied carried a number of juveniles on the dorsal side, posterior to the umbo. These shells have a prominent umbo and the maximum length is about 0.3 mm. There is only a very slight variation in shape and size of the juveniles. Several adults between 1 and 2 mm long have one juvenile, the type specimen has 6, and one specimen about 2.3 mm long has ten – this being the largest number observed.

Affinities:

The present differs from all known species of *Xylophaga* by having a mesoplax with 4 frontal lobes. The siphon is similar to that of *X. erecta* and *concava.*

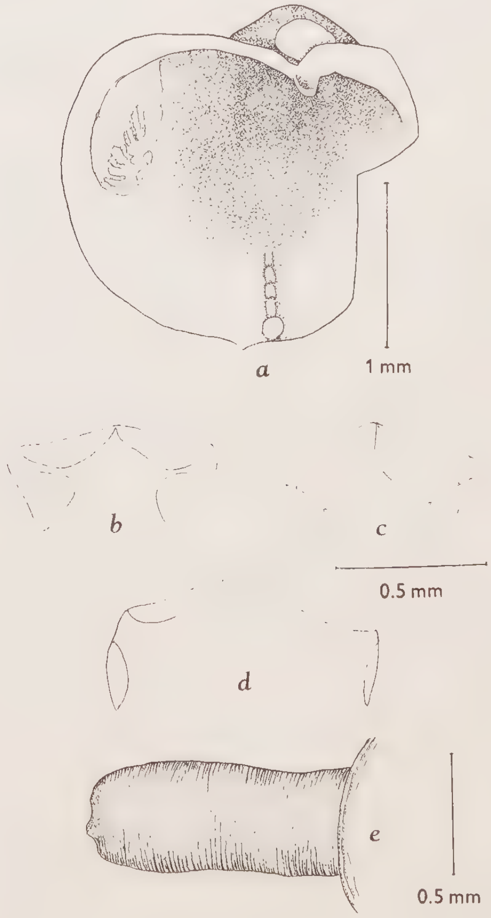


Fig 7. *Xylophaga lobata* n. sp., paratypes; a, internal side of the left valve; b, c, d, frontal view of the mesoplax of three specimens showing the variation in the development of the lobes; e, siphon seen from the right side.

Xylophaga galatheae n. sp.

(Fig. 8, 9)

Material:

St. 550, Tasman Sea (31°27'S, 153°33'E), 4530 m, 12. Nov. 1951. Gear: ST200+D45+SSD. Bottom: very stiff clay. Bottom temperature: about 1.0° C. – Numerous specimens found in situ in small twigs. Many were left in situ. Unfortunately the whole material was preserved dry, so the soft parts could not be studied. One specimen only was found with the mesoplax preserved and this was selected as a type.

Diagnosis:

Xylophaga with a triangular mesoplax with ventrally projecting frontal lobes, widely spaced ridges on the beak and a large posterior muscular impression.

Description:

The shell is small and semi-transparent with a low umbo, which has an indistinct rounded edge. The beak extends less than half the distance to the ventral edge of the shell; the postero-dorsal edge extends beyond the umbo and is slightly reflected. The umbonal reflection is well developed, its posterior part connected with the umbo, and its dorsal edge reflected. The breadth of the anterior incision is about one third the total breadth of the shell. The prodissoconch visible in nearly all specimens; it is distinctly marked off from the adult shell, and has a maximum length of about 0.3 mm. The ribs of the beak are widely spaced, the interstices being 3-4 times the breadth of a rib. The oblique ridges of the anterior slope are widely separated posteriorly. The umbonal-ventral sulcus is shallow and is bound anteriorly and posteriorly by a low rounded edge which extends from the posterior part of the umbo down the shell. The posterior slope rather smooth, a fine concentric striation near the edge of the shell being visible when greatly magnified. Interior of the shell: The posterior muscular impression large and oval. Ventrally, it extends about $^2/_3$ the distance to the ventral margin of the shell; it is elongate and located close to the posterior edge. A faint edge is present anterior to the dorsal part of the muscular impression. The umbonal-ventral ridge is distinct, segmented and has a prominent condyle. The mesoplax consists of two triangular, curved plates; the median edges diverge anteriorly. The antero-median part of each plate is ventrally curved. In frontal view the curved parts form two frontal lobes. Siphon: unknown.

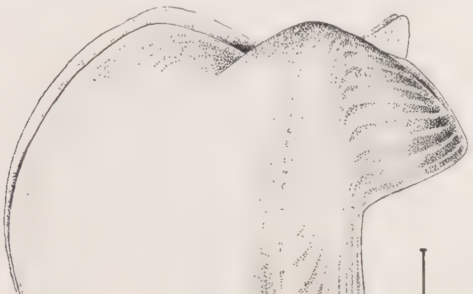


Fig. 8. *Xylophaga galatheae* n. sp., holotype; lateral view of the right shell; b, dorsal view. P. H. W.

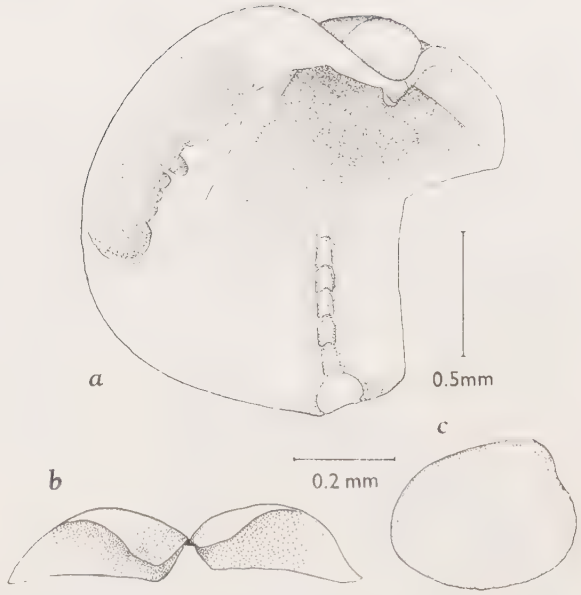


Fig. 9. *Xylophaga galatheae* n. sp.; a, internal view of the left shell, paratype; b, frontal view of the mesoplax, holotype; c, juvenile.

Dimensions of the type specimen:

Length: 2.0; height: 1.8; breadth: 1.8.

Reproduction:

In the type specimen a single small bivalve, presumably a juvenile *Xylophaga,* is attached to the dried-up soft parts. It has a length of about 0.3 mm, and thus is of about the same size as the prodissoconchs measured.

Affinities:

X. galatheae resembles *lobata* in several respects: i. e. the mesoplax, the widely spaced ridges of the beak, and the sculpture of the shell as a whole. In *lobata,* however, there are two frontal lobes on each plate of the mesoplax, while *galatheae* has only one. There are also obvious differences in the two species in the shape of the umbonal reflection, in the outline of the shell, and the shape and sculpture of the posterior muscular impression.

Xylophaga panamensis n. sp.

(Fig. 10, 11)

Material:

St. 739, Gulf of Panama (7°22'N, 79°32'W), 915-975 m, 15. May 1952. Gear: HOT. Bottom: green clay. Bottom temperature: about 5.0° C. – 1 dried up specimen.

Diagnosis:

Xylophaga with a longitudinally folded mesoplax with a median edge of about half the length of the basal edge. The beak is short with widely spaced ridges and a curved ventral edge.

Description:

The shell is small and fragile and has a rather low umbo. The beak is short, occupying less than half the distance to the ventral edge of the shell. The ventral edge is curved upwards forming an obtuse angle with the ventro-anterior edge of the shell. The umbonal reflection is very small, forming only a raised edge and the anterior incision is very narrow, forming an acute angle of around 25°. The prodissoconch is not visible. The ridges of the beak are widely separated and become more distant towards the ventral edge, where the interstices are three to four times the breadth of a ridge. The umbonal-ventral sulcus is broad and only slightly depressed: it is bound by two raised ridges, of which the anterior is slightly developed and narrow, while the posterior is broad and prominent. The latter appears on the internal side of the shell as a rounded furrow. The umbonal-ventral sulcus has a faint irregular striation and the sculpture on the posterior slope consists of a number of indistinct, widely spaced concentric furrows and a fine irregular striation. Interior of the shell: The posterior muscular impression is very distinct, and is oval in shape, the anterior part being divided up into a number of irregular lobes. The umbonal-ventral ridge is less prominent than usual and the segmentation is faintly developed and irregular. There is no condyle. The mesoplax consists of two longitudinally folded plates, pointing towards the umbo, the anterior part being covered. The basal edge is about twice as long as the median edge.

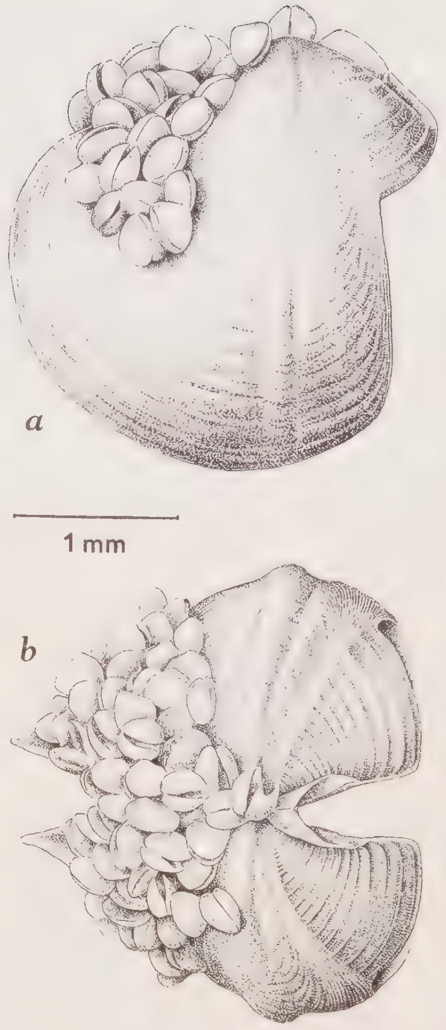


Fig. 10. *Xylophaga panamensis* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

Dimensions of the type specimen:

Length: 2.6; height: 2.6; breadth: 2.7.

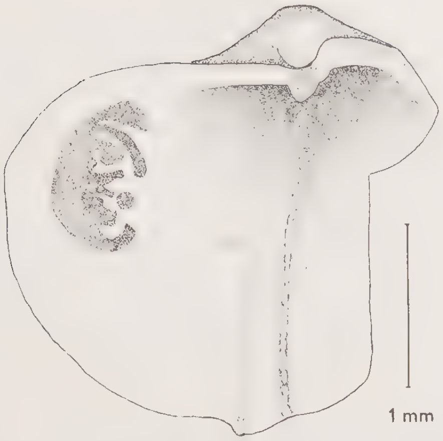


Fig. 11. *Xylophaga panamensis* n. sp., holotype; internal side of the left valve.

Reproduction:

About 50 embryos were attached to the postero-dorsal part of the shell, extending about half way down towards the ventral edge. The embryos which had not at this stage developed a beak, were all roughly the same size, measuring about 0.38 mm in length.

Affinities:

The present species would seem to be most closely related to *X. galatheae*, which has a similar type of mesoplax, sculpture and shape of beak. In *galatheae,* however, the anterior incision is much broader than in *panamensis*, and at the same time, the relative width of the mesoplax is larger. In *galatheae* the ridge posterior to the umbonal-ventral sulcus is only faintly developed, while it is rather strong in *panamensis.* In the latter species the outline of the postero-dorsal edge of the shell is concave, whereas it is strongly convex in *galatheae,* extending dorsally beyond the umbo.

Xylophaga hadalis n. sp.

(Fig. 12, 13)

Material:

St. 658, Kermadec Trench (35°51'S, 178°31'W), 6660-6770 m, 20. Febr. 1952. Gear: ST 600. Bottom: brown sand with clay and stones. Bottom temperature: 1.3° C. – 1 specimen.

Diagnosis:

Xylophaga with a relatively small horizontal mesoplax occupying only a small part of the anterior incision. Each plate is triangular, with an irregular dorsal surface. The siphon is short and wide, having both openings at the tip.

Description:

The shell is large and thin with a prominent umbo. The latter has a prominent rounded edge on the posterior part, which continues down the shell, becoming broader and less pronounced towards the ventral edge. The beak extends less than half the distance to the ventral edge of the shell. The umbonal reflection is well developed, triangular in shape and attached posteriorly to the anterior part of the umbo. The dorsal part of the umbonal reflection is

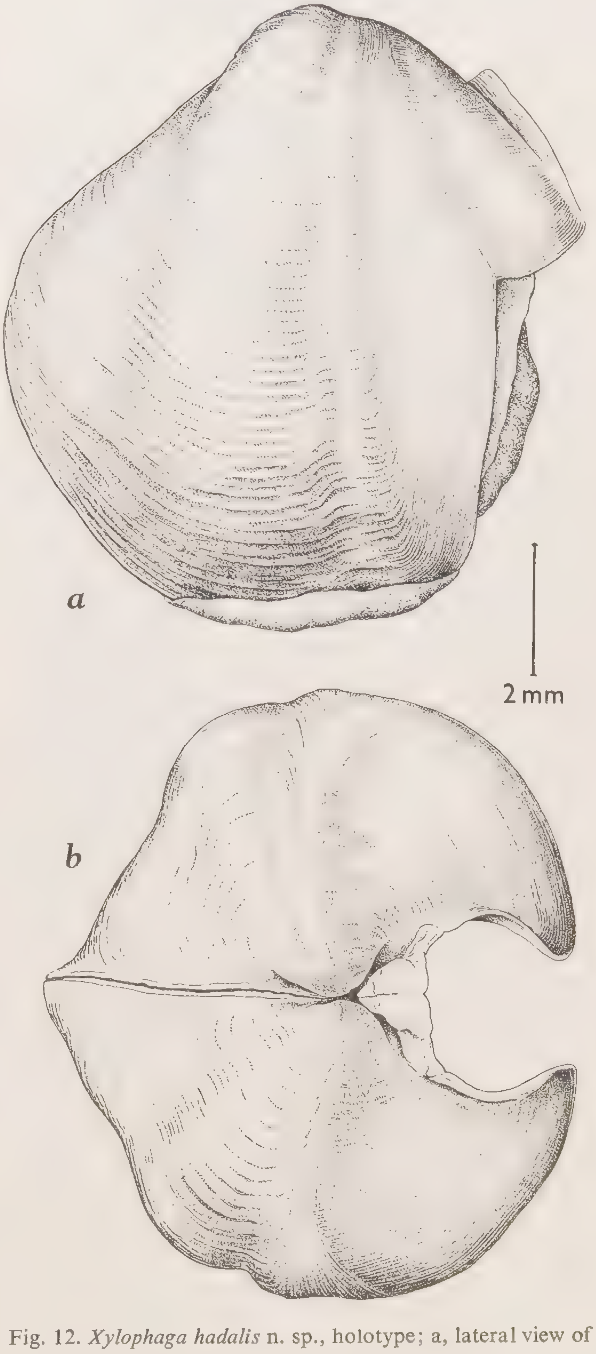


Fig. 12. *Xylophaga hadalis* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

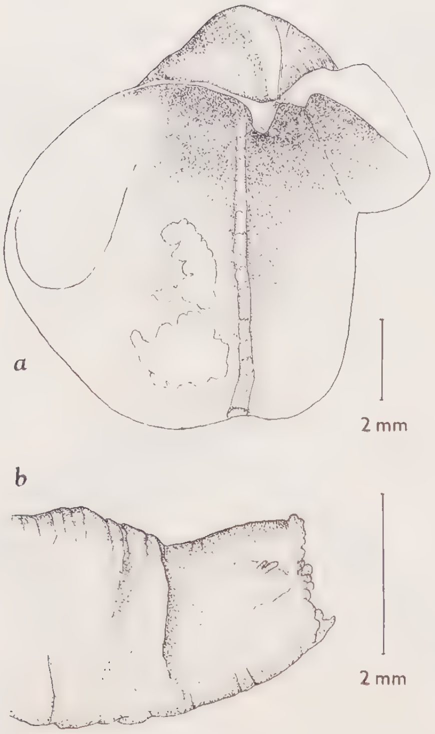


Fig. 13. *Xylophaga hadalis* n. sp., holotype; a, internal side of the left valve; b, siphon seen from the left side.

semi-transparent. Both shells have a denticle located on the ventral part of the umbonal reflection, close to the chondrophore. The anterior incision is subcircular, the maximum breadth being a little less than one third of the maximum breadth of the shell. Prodissoconch is not visible. The ridges of the beak become more close-set towards the ventral edge. Near the umbo the interstices are about three times the breadth of the ridges while in the ventral part they are about the breadth of a ridge or even narrower. The umbonal ventral sulcus is a distinct depression without a central groove; there is a slight rounded edge anterior to it and posteriorly, it is bound by the rounded umbonal edge already referred to. The oblique ridges of the anterior slope continue across the sulcus and the posterior slope as distinct, flat concentric ridges; they are regularly spaced dorsally, becoming more narrow and irregular towards the ventral edge of the shell. On the dorsal part of the shell the interstices between the concentric ribs are about half as broad as the ribs, becoming narrower further ventrally. The concentric sculpture is less regular and obsolete towards the posterior edge of the shell. Interior of the shell: the posterior muscular impression is indistinct and without sculpture. It is located close to the posterior edge and extends a little more than half the distance to the ventral edge of the shell. The umbonal-ventral ridge is distinct, segmented, and devoid of a condyle. Between the posterior muscular impression and the umbonal-ventral ridge several irregular callosities are present.

The mesoplax consists of two simple and irregular plates, occupying only about one fourth of the total area of the anterior incision. The posterior end of the mesoplax is pointed, the basal edges are rather irregular, and the median edge is nearly straight. The dorsal surface of each plate has a distinct furrow extending from the basal edge and separating the anterolateral part of each plate. It should be mentioned that Dr. RUTH TURNER has suggested that the mesoplax in this specimen might be abnormal.

The siphon is thin walled and has completely collapsed. Its total length is about 5 mm. Both openings are at the distal end, close together, and a large number of very small cirri are present round the opening; inside the exhalant opening a few larger cirri can be observed.

Dimensions:

Length: 8.9; breadth: 9.3; height: 9.5.

Reproduction:

Nothing known.

Affinities:

Owing to the (possible abnormal), appearance of the mesoplax and the poor condition of the siphon, it might seem premature to describe the single specimen as a new species, since a comparison with other species cannot be carried out properly without greater knowledge of these two important characters. The present species would seem to be closely related to *turnerae* (see pag. 184). In both species the mesoplax consists of two triangular plates occupying only a small part of the anterior incision. In both species the beak and the umbonal reflection are very much alike. In *turnerae,* however, the lateral parts of the mesoplax are bent ventrally, while in *hadalis* the plates of the protoplax are nearly flat. Both shells have a distinct concentric sculpture. In *turnerae* there is a rather narrow, rounded edge posterior to the umbonal-ventral sulcus. In *hadalis* the corresponding edge is much broader. Further, the shape of the muscular impression is different in the two species, being elongate in *hadalis,* but almost circular in *turnerae*. The two species differ widely in the siphon.

Xylophaga duplicata n. sp.
(Fig. 14, 15)

Material:

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST 600. Bottom: green clay. Bottom temperature: about 5.0° C. – 2 specimens. A specimen with the mesoplax preserved but a somewhat damaged siphon has been selected as a holotype. The paratype has lost the mesoplax, but the siphon is in perfect condition.

Diagnosis:

Xylophaga with a vertical, duplicated mesoplax and a siphon partly covered with periostracum, having both openings at the tip.

Description:

The shell is rather small, thin, and semi-transparent. The umbo is low, rounded and broad. The beak extends about half the distance to the ventral edge of the shell. The anterior incision is broad with distinct lateral extensions. The umbonal reflection is only slightly developed, forming an erect edge, and does not cover the umbo. The prodissoconch is not visible. The ribs of the beak are fine and close-set throughout, slightly more so towards the ventral edge. The umbonal-ventral sulcus is a simple shallow groove, bound posteriorly by a faint rounded ridge. The posterior part of the shell has a very fine, irregular, concentric sculpture. Interior of the shell: The posterior muscular impression is oval and very indistinct. Anterior to the muscular

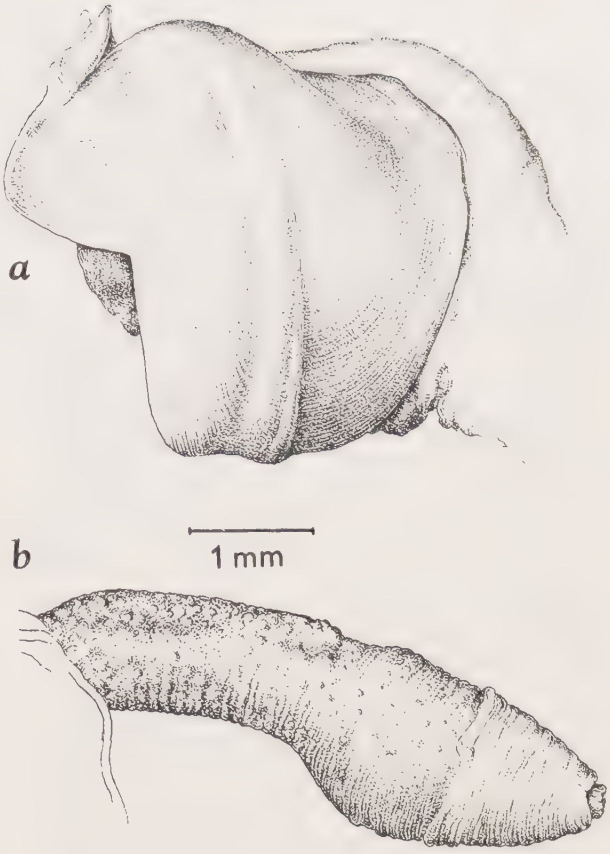


Fig. 14. *Xylophaga duplicata* n. sp.; a, lateral view of the left shell, holotype; b, siphon seen from the left side, paratype. P. H. W.

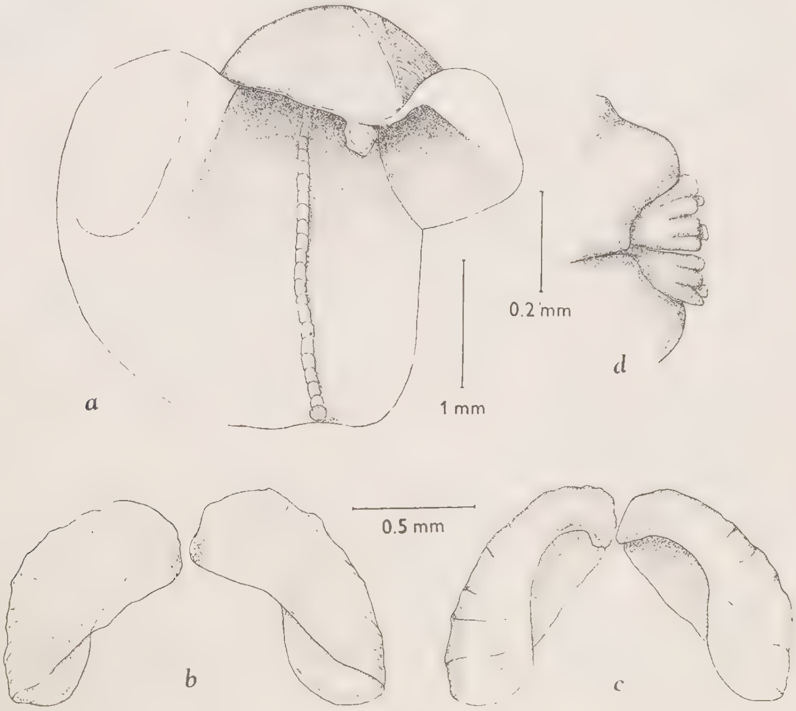


Fig. 15. *Xylophaga duplicata* n. sp.; a, internal side of the left valve of paratype; b, mesoplax of the holotype, frontal view; c, mesoplax of the holotype seen from behind; d, posterior end of the siphon of paratype seen from the left side.

impression is a prominent rounded ridge, extending from the posterior part of the umbo to about half way down the ventral edge of the shell. The umbonal-ventral ridge is prominent and distinctly segmented, the condyle being only slightly developed.

The mesoplax is vertical. The two plates are duplicate, the anterior adductor muscle partly extending into the cavity of the plate. At their bases the plates are widely separate, although they touch at the top, which is curved inwards. The plates have fine, regularly spaced, transverse ridges, which are particularly distinct on the dorsal (posterior) surface.

Siphon: The posterior part of the mantle protrudes from the shell and the siphon extends about $1^{1}/_{2}$ times the length of the shell. It is somewhat compressed laterally, the distal half being rather inflated. On each side of the siphon there is an indistinct longitudinal groove. The proximal $^{3}/_{4}$ of the siphon is covered by a thin brownish periostracum which has numerous rounded, white spots; the uncovered distal part is of a whitish colour. Both openings of the siphon are at the tip, situated on separate short tubes which are very close together: each one is surrounded by 6-8 small cirri.

Dimensions of the type specimen:
Length: 3.7; height: 3.5; breadth: 3.4.

Reproduction:
nothing known.

Affinities:
The present species is distinguished from all other species of *Xylophaga* by its mesoplax and the siphon.

Xylophaga grevei n. sp.
(Fig. 16, 17, 18)

Material:

St. 443, Mindanao Sea (8°48'N, 124°09'E), 1500 m, 16. Aug. 1951. Gear: D80 and D45. Bottom: mud, many fragments of plants. – 4 nearly complete shells and some fragments. Mesoplax and soft parts are lacking.

St. 490, Bali Sea (5°25'S, 117°03'E), 570-545 m, 14. Sept. 1951. Gear: ST300+D80+D45. Bottom: sand and clay. – 2 specimens, 1 left shell.

St. 495, Banda Trench (5°26'S, 130°58'E), 7290-7250 m, 22. Sept. 1951. Gear: HOT. Bottom: clay. Bottom temperature: 3.6° C. – 1 specimen.

The specimen from St. 495 has been selected as the type.

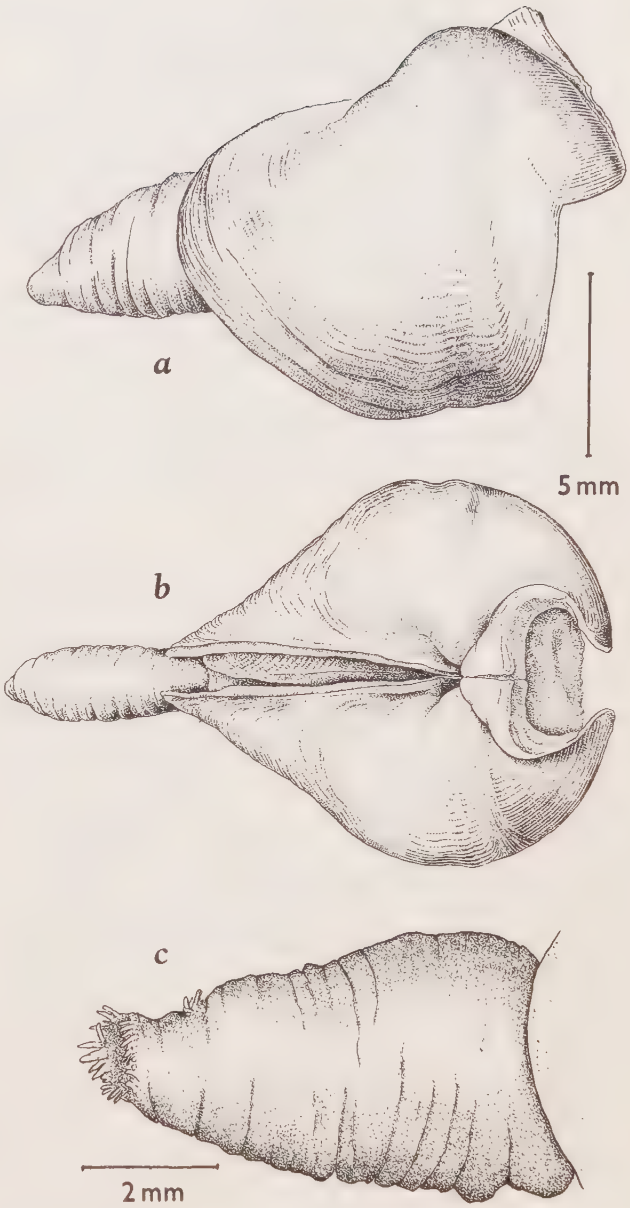


Fig. 16. *Xylophaga grevei* n. sp., holotype; a, lateral view of right shell; b, dorsal view; c, siphon seen from the right side; a, & b: P. H. W.

Diagnosis:

Xylophaga having a mesoplax consisting of triangular plates bent along the basal edges, the opening of the excurrent siphon located a short distance from the incurrent opening.

Description:

The umbo is comparatively large. The beak extends somewhat less than half the distance to the ventral edge of the shell. The anterior incision is broad, being approximately one third the total breadth of the shell. The outline of the posterior part of the shell seen from the dorsal side is either straight or slightly concave. The umbonal reflection is well developed and the posterior part overlaps the anterior part of the umbo, but no projecting lobes are present. None of the available shells had the prodissoconch preserved. The beak has numerous close-set ridges which gradually become extremely dense towards the ventral edge. The anterior slope has innumerable fine ridges which are more numerous than those on the beak. The umbonal-ventral sulcus is wide and shallow. Both the sulcus and the posterior slope have a rather coarse concentric sculpture. In the sulcus, the spaces between the concentric ridges are roughly of the same breadth as the ridges. Posterior to the sulcus the breadths of the ridges increase and the interstices gradually disappear. In addition to this coarse sculpture, a finer concentric sculpture is found, which is particularly distinct on the anterior part of the concentric ridges, while on the posterior slope it covers the whole of the shell. Interior of the shell: The posterior muscular impression is large, pear-shaped and is located dorsally, close to the edge of the shell; it shows a faint oblique striation. The umbonal-ventral ridge is prominent, segmented and has a distinct ventral condyle.

The mesoplax is triangular; the median edge is short, and the anterior edge is higher than the posterior part, showing a fine transverse striation. The lateral parts of the plate are bent ventrally to form two long and pointed lobes.

The present material shows rather little variation, except that in the larger specimens the sculpture is somewhat coarser than in the smaller. The mesoplax is present in the type and in one specimen from St. 490; both being practically identical in size and appearance.

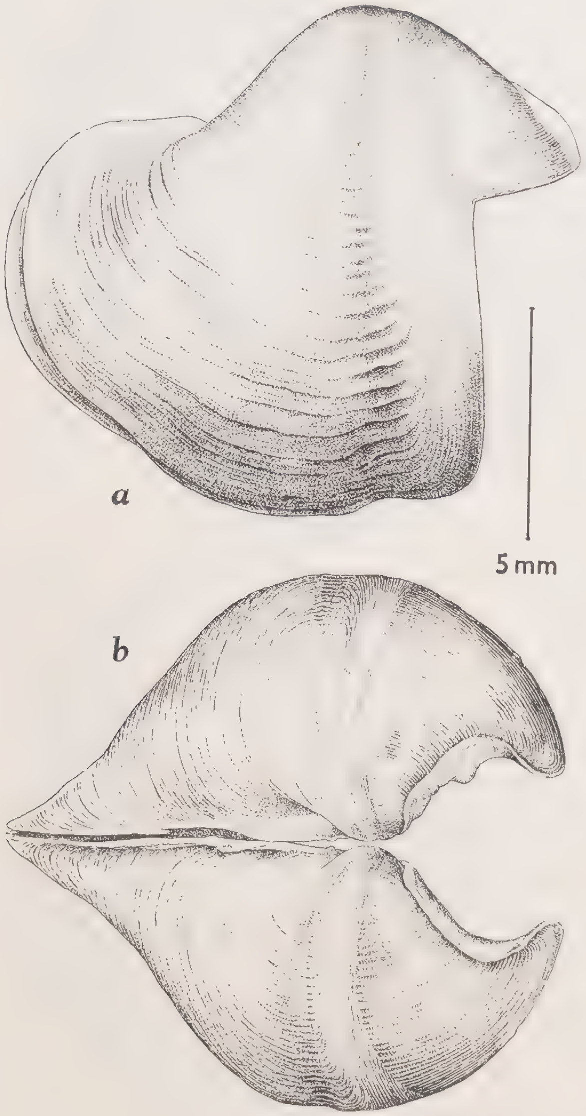


Fig. 17. *Xylophaga grevei* n. sp., valves of a specimen from St. 490; a, lateral view; b, dorsal view. P. H. W.

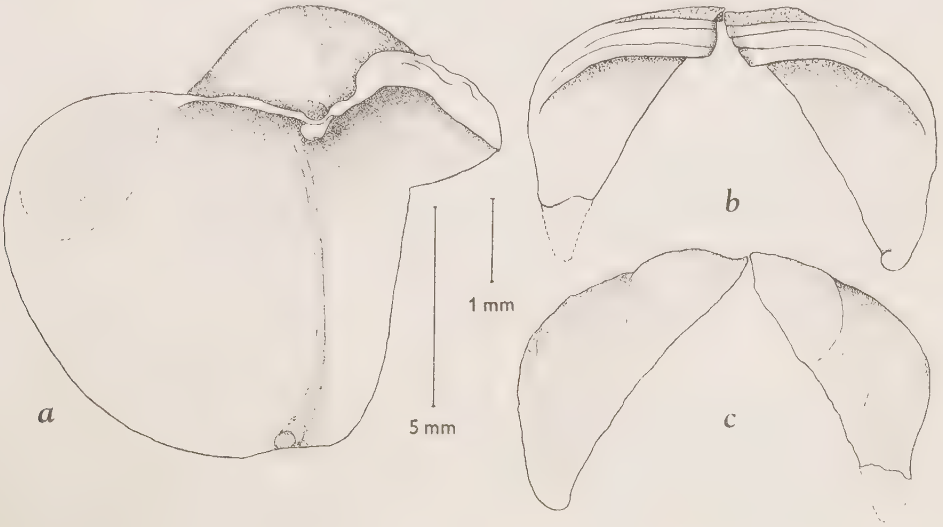


Fig. 18. *Xylophaga grevei* n. sp., holotype; a, internal side of the left valve; b, frontal view of mesoplax; c, posterior view of mesoplax.

The siphon is present only in the type specimen and seems to be somewhat contracted. It is thick-walled and the length is somewhat less than half the length of the shell. The excurrent opening is located close to the incurrent one and there are no lappets on the dorsal side between the excurrent and incurrent openings. The latter opening has about 35 small cirri, while about 6 cirri are present on the dorsal edge of the former.

Dimensions of the type specimen:
Length: 12.5; breadth: 10.7; height: 11.0.

Reproduction: nothing known.

Affinities:

The mesoplax is of the same type as that found in *X. praestans* Smith, *washingtona* Bartsch and *atlantica* Richards viz.; a triangular plate with the basal edges bent ventrally. In the firstmentioned species the reflected edge of the mesoplax is relatively large, as in *grevei*, in the former, the ventral part forms two long, pointed lobes, while in the latter the lobes are much shorter, the tips forning approximately a right angle.

In both *washingtona* and *atlantica* the reflected edges of the mesoplax are very small. The siphon of the present species is similar to that of *atlantica* Richards. It would seem, however, that in *grevei* the two openings of the siphon are closer together than in *atlantica*, but this may be due to contraction of the siphon. The present species seems to differ from all other known species by the coarse concentric sculpture of its shell.

The species has been named after Captain Svend Greve, R.D.N., Commander of the *Galathea*.

Xylophaga foliata n. sp.

(Fig. 19, 20)

Material:

St. 453, Macassar Strait (3°56'S, 118°26'E), 2000 m, 24. Aug. 1951. Gear: ST 300. Bottom: greenish clay. Bottom temperature: 3.6° C. – 2 specimens. No record of any plant material from this station.

Diagnosis:

Xylophaga with an accessory piece of shell attached to the posterior part of each plate of the mesoplax; the latter is folded longitudinally and has an irregularly folded anterior edge. Siphon small with the two openings close together.

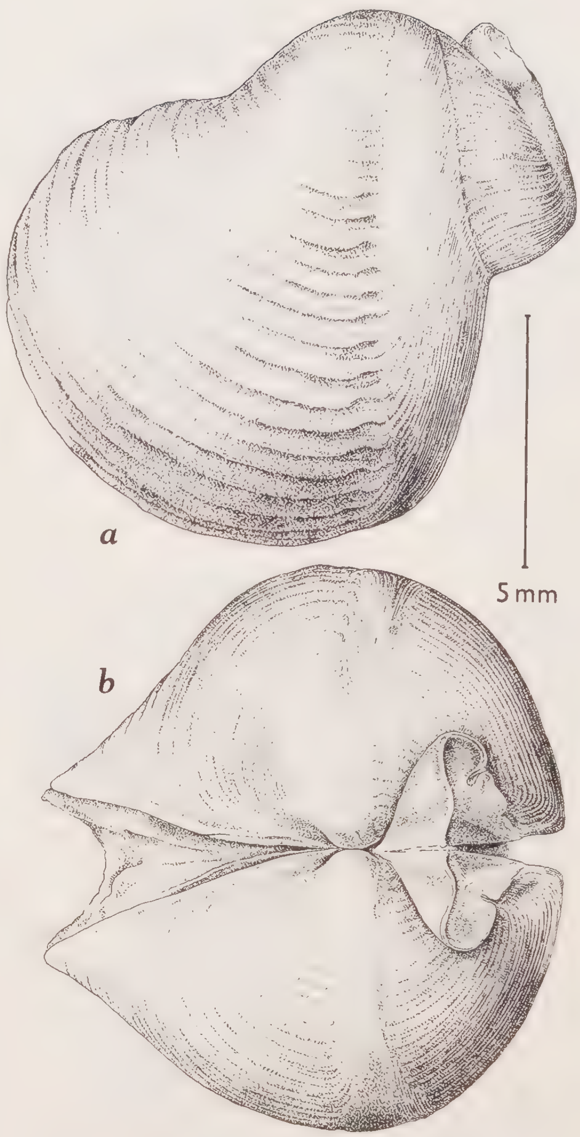


Fig. 19. *Xylophaga foliata* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

Description:

The shell is rather large and opaque, with a prominent umbo. The beak extends somewhat less than half the distance to the ventral edge of the shell. The umbonal reflection is well developed, triangular, the dorsal edge strongly reflected and adhering to the underlying part of the shell. A rounded nodule is present near the umbo. Seen from the dorsal side the anterior incision has almost straight edges, the maximum breadth is about one seventh of the maximum breadth of the shell. The prodissoconch is not visible. The two shells gape posteriorly. The ridges of the beak are far apart, the interstices being about three times the breadth of the ribs, except ventrally, where the ribs become more closely set. The oblique ridges of the anterior slope

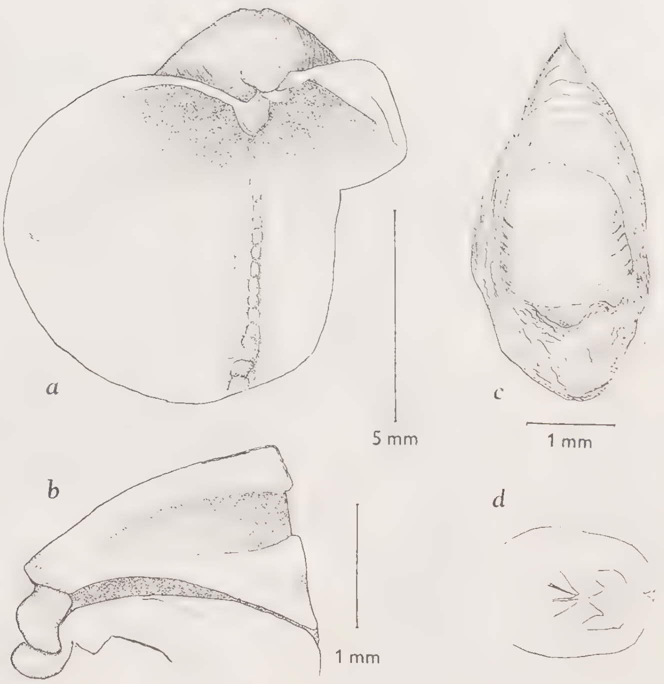


Fig. 20. *Xylophaga foliata* n. sp.; a, internal side of the left valve of the holotype; b, internal side of the left plate of the mesoplax of the holotype. The umbonal reflection is seen below and to the left, the small accessory plate connecting the posterior end of the plate with the nodule of the umbonal reflection is to be seen; c, posterior part of the mantle and the dorsally reflected, tongue shaped siphon, paratype; d, dorsal view of the siphon, paratype. Dotted area indicates the incurrent opening. The excurrent opening is found below the three tentacles to the left. Somewhat diagrammatic.

are very fine and close-set. The umbonal-ventral sulcus is a very shallow depression without any central groove or ribs. A distinct concentric sculpture starts around the sulcus; it consists of broad and flat ribs, which are spaced by interstices about half as broad as the ribs. Posterior to the umbonal-ventral sulcus the ribs are somewhat narrower, and the intercostal spaces appear here as a dorso-ventral row of rather deep pits. The concentric ribs become somewhat obsolete towards the posterior end of the shell. Interior of the shell: The posterior muscular impression is rather indistinct, pear-shaped and comparatively small; the dorsal part having a faint oblique striation. The umbonal-ventral ridge rather prominent, segmented and with a condyle at the ventral edge.

The mesoplax consists of two plates, which are longitudinally bent. The dorsal part is a triangular plate which is pointed posteriorly. The median edge is straight as the basal edge. The curved anterior edge is rather irregular and a number of deep incisions are present on the ventral half of the edge. On the internal posterior part of the mesoplax, each plate has a rounded protuberance to which is inserted one end of a cylindrical piece of shell, the other end of is fixed to the nodule on the umbonal reflection already mentioned. This peculiar arrangement seems to be unique in the Pholadidae.

The siphon is rather small and in neither of the two specimens does it protrude beyond the posterior edge of the shell. It is bent dorsally and the openings are difficult to study in detail; its total length is about 3 mm. The incurrent opening has a small number of cirri, the excurrent opening is located close to the incurrent one and is surrounded by three lobes.

Dimensions of the type specimen:
Length: 11.1; breadth: 11.3; height: 10.5.

Reproduction: nothing known.

Affinities:

X. foliata would seem to be related to *grevei*, which has the same type of ventrally curved mesoplax. In the latter species, the anterior edge of the mesoplax is regular and without incisions, and the accessory shell piece in *foliata* is not found in *grevei*. The two species differ in the shape of the umbonal reflection, while they agree in the faint development of the umbonal-ventral sulcus and the distinct concentric sculpture of the posterior part of the shell. They both have the same type of siphon, the two openings being close together. It would seem, however, that the number of tentacles surrounding the openings in *grevei*, is greater than in *foliata*.

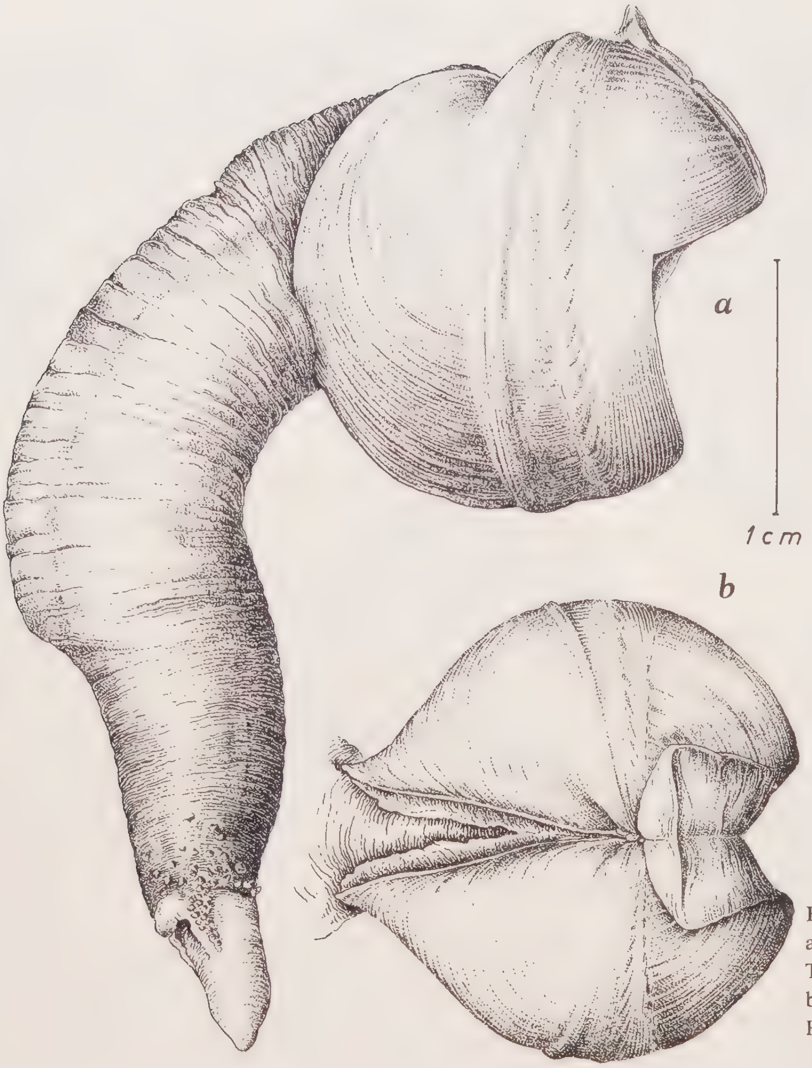


Fig. 21. *Xylophaga praestans* E. A. Smith; a, lateral view of a specimen from the Trondheimsfjord, W. coast of Norway; b, dorsal view of the same specimen. P. H. W.

Xylophaga praestans E. A. Smith, 1903
(Fig. 21, 22, 23)

Xylophaga praestans Smith, 1903, p. 328, figs. 3-4; Tomlin 1920, p. 73; Dons 1929, p. 169, figs. 1-7; 1933, p. 191, figs. 1-2; Purchon 1941, p. 3, fig. 1.

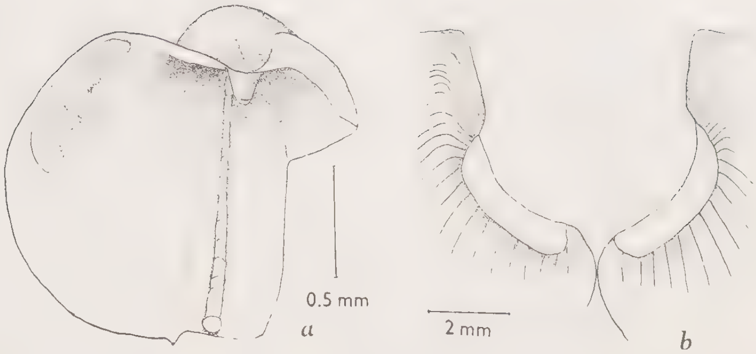
Original description:

Testa *X. dorsalis* similis sed major, area antica filiis fortioribus et magis distantibus instructa, linea arcuata impressa ab umbone ad angulum anticum sculpta, laminis duobus dorsalibus (protoplaxibus) formæ dissimilis et diverse positis; cicatrix postica intra valvas rugose striata. Diam. 18 mm., longit. umbone ad marginem ventralem 17.5 mm.

Remarks:

In addition to the above diagnosis Smith, (1.c.) gives two figures of the mesoplax, and states that the species had been extracted from an old mast at Blyth on the coast of Northumberland (N. E. England). Smith further states that he was in some doubt whether his species was actually different from *Xylophaga dorsalis* (Turton), – a species known from numerous localities in the coastal area of the N. E. Atlantic He does point out, however, that *praestans* is a much larger species than *dorsalis*. In addition, there are marked differences in the sculpture of the beak, the ridges being much farther apart in *praestans* than in *dorsalis*. Further differences are found in the mesoplaxes of the two species and in the posterior muscular impression. Tomlin (1. c.) gives some further details, which were handed over by the collector of Smith's material. It appears that the species has been found in several places off the Durham and Northumberland coast at depths ranging from 25-45 fathoms (46-82 m), and always in pitchpine logs or masts that had been immersed in the water for some considerable time. This species is stated to have a fairly long siphon and the largest specimens are $1^{1}/_{8}$ inch in diameter (28 mm). It is interesting to

Fig. 22. *Xylophaga praestans* E. A. Smith; a, internal side of the left valve of a specimen from the Trondheimsfjord; b, dorsal view of the specimen, showing the anterior incision and the umbonal reflection.



note that the species is reported to be phosphorescent at night. Dons (1929) reported *praestans* from various localities in the Trondheimsfjord, Norway (about 63°30'N). He also called attention to the large size of the species compared to *dorsalis*; the largest specimens of *praestans* being 23.5 mm long, while the largest specimen of *dorsalis* seen by Dons was 13 mm long. Dons gives some photographs of the species, including one showing the large siphon. In addition, outline drawings of mesoplaxes are given to show the variation in shape within the species. The depth range of the material listed by Dons is 30-60 m. Dons (1933) reported *praestans* from a Quarternary deposit from Stjørdal, near Trondheim. In addition, a piece of wood attacked by *praestans* is figured. The holes excavated in the wood may attain a length of up to 20 cm with a maximum diameter of 28 mm. The growth is reputed to be rather fast since already by attaining half of its length the hole has a diameter of 22 mm. Purchon (1941) mentions and figures a piece of timber bored by a species other than *dorsalis,* probably *praestans* Smith, obtained off the S. W. coast of England.

The present author has had the opportunity to study both Smith's type material which is in the British Museum (Nat. Hist.), London, and a fine series of specimens from the Trondheim Museum comprising the specimens dealt with by Dons. The material from Trondheim contains about 30 specimens in alcohol and gives a good opportunity to study in more detail this little known species. A comparison between Smith's type material of *praestans* and the material from the Trondheim Museum shows that the latter should be referred to *praestans.*

Description:

The shell is thick and non-transparent in adult specimens. The umbo is not very prominent for the genus and has a posterior, rounded edge. The beak extends somewhat less than half the distance to the ventral edge of the shell. The distance from the anterior edge to the base of the beak is only slightly less than the total height of the beak. The anterior incision has a maximum breadth of about $^{1}/_{3}$ of the total breadth of the shell. The umbonal reflection is fairly small and fixed to the underlying part of the shell, it does not cover the umbo. In none of the specimens studied could the prodissoconch be observed. The beak has several ridges which are widely spaced on the dorsal part, the breadth of the interstices being 2-3 times the breadth of the ridges. Towards the ventral edge of the beak the ridges become more close-set, and in the larger specimens, the breadth of the interstices is much less than the breadth of the ridges. The umbonal-ventral sulcus is a shallow groove bound by two distinct ridges; the posterior being much more developed than the anterior one. The former appears as a distinct notch at the ventral edge of the shell. The area of the anterior slope, anterior to the umbonal-ventral sulcus, has regular short ridges running parallel to the ventral edge of the shell – in continuation of the oblique ridges of the anterior slope – and are present in the same number. The umbonal-ventral sulcus has a distinct, irregular striation. Interior of the shell: The posterior muscular impression is oblong and narrow, located dorsally, and close to the edge of the shell. It has a distinct oblique striation. The umbonal-ventral ridge is very prominent, segmented and without a condyle.

The mesoplax: consists of two plates; the lateral parts of the posterior edges, being ventrally bent to form two triangular pointed lobes. There is some variation in the shape of the mesoplax, obviously related to the size of the animal. In small specimens the anterior and posterior edges of the plates are curved, while in larger specimens they will form straight or almost straight lines.

The siphon is very well developed; in the most extended specimens seen, its length is more than $2^{1}/_{2}$

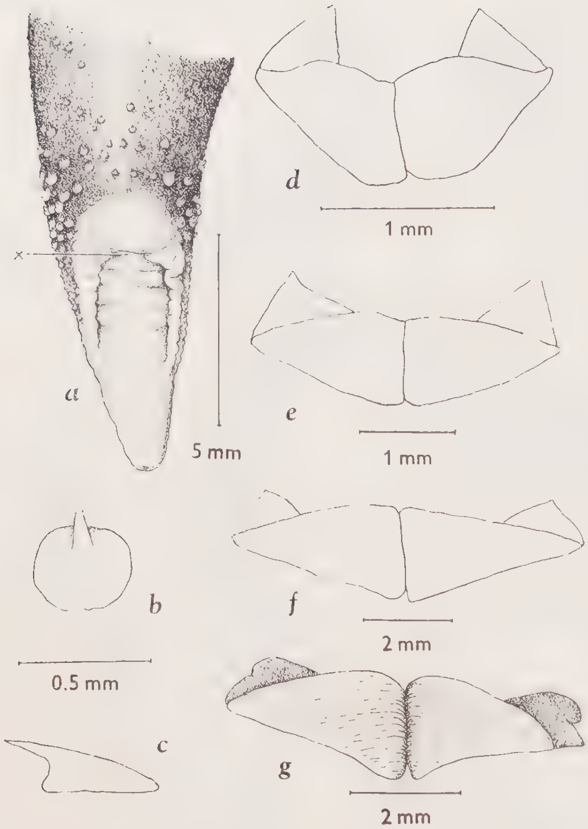


Fig. 23. *Xylophaga praestans* E. A. Smith; a-f, Trondheimsfjord; g, holotype from British Museum (N. H.); a, dorsal view of the posterior end of the siphon. The excurrent opening is located at the x. P. H. W.; b and c, spine from the epidermis of the siphon seen from above and in lateral view; d-g, mesoplax of four specimens showing the variation in size and shape. Total lengths of shells: d, 5mm; e, 8.4 mm; f, 17 mm; g, (type) 18 mm.

times the length of the shell. For the most part it is covered by a brown periostracum, as is also the posterior, protruding part of the mantle. The distal part of the siphon is devoid of periostracum. The periostracum extends upto the excurrent opening which is a transverse slit located in the most extended specimens, 5 to 10 mm from the incurrent opening. Both openings are without cirri. From the excurrent opening to the tip of the siphon there is a groove bound laterally by two rounded folds. The distal part of the periostracum and the adjoining part of the uncovered siphon have numerous calcareous bodies, some having a rounded base and an anteriorly curved spine: others being only rounded nodules. On the proximal part of the uncovered siphon, most of the calcareous bodies are arranged in two lateral rows.

Reproduction: nothing known.

Affinities:

Up to the present, three species of *Xylophaga* have been recorded from the North Atlantic, viz. besides *praestans* E. A. Smith: *dorsalis* (Turton), *atlantica* Richards. *X. atlantica* has a similar type of siphon which is, however, shorter and never extends more than the length of the shell. In addition, it is devoid of periostracum, and has papillae at the openings. The mesoplax of *atlantica* is somewhat similar to that of *praestans*, but the bent posterior edges do not form triangular lobes, as is the case in the latter. In addition, the mesoplax in *atlantica* occupies less than half the anterior incision, while in *praestans* the whole incision is filled out by the mesoplax. *X. dorsalis* has a small siphon and the excurrent opening is located at the base. From this, two rows of lappets extend on the dorsal side to the incurrent opening. The mesoplax of *dorsalis* consists of two relatively large, flat plates covering the umbo; the basal edge is curved. In *Xylophaga aurita* (see below) a somewhat similar type of siphon is found. The excurrent opening of the latter species is, however, closer to the base of the siphon and the latter is not covered by a periostracum. Further, the siphon in *aurita* is comparatively smaller than the siphon of *praestans* and is ventrally bent.

Xylophaga aurita n. sp.
(Fig. 24, 25)

Material:

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST 600. Bottom: green clay. Bottom temperature: about 5.0° C. – 9 specimens taken from a sunken tree trunk.

Diagnosis:

Xylophaga with a vertical mesoplax consisting of two fan-shaped plates and a ventrally bent siphon. The excurrent tube of the latter is truncated close to the posterior edge of the shell, and the dorsal surface of the siphon has a groove which is bound laterally by continuous walls.

Description:

The shell is thin and semi-transparent; umbo low and broad. The beak of the anterior slope extends about half the distance of the ventral edge of the shell and is truncated anteriorly. The anterior incision is broad with lateral angles; its breadth is slightly less than $^1/_2$ the breadth of the shell. The distance from the anterior edge to the base of the beak is about $^3/_4$ the height of the beak. The umbonal reflection is comparatively large, rounded, triangular in shape and does not cover the umbo. In a few of the specimens the prodissoconch could be observed (absent in the type). It is light yellow in colour and measures about 0.4 mm in length. The posterior part of the shell is comparatively short. Seen from the dorsal side, the posterior part of the edge of the shell is reflected. The beak has numerous close-set ridges. The umbonal-ventral sulcus is a rather faint depression. The umbonal-ventral sulcus and the posterior part of the shell have a faint but distinct concentric sculpture consisting of regular ridges spaced by narrow interstices. Posterior to the umbonal-ventral sulcus the breadth of the interstices are roughly equal to those of the ridges. The concentric sculpture becomes more irregular towards the posterior end of the shell, and at the same time, the ridges become much more narrow; in addition to this sculpture there is a fine concentric striation. Interior of the shell: The posterior muscular impression large and oval, occupying the whole posterior part of the shell and extending to the edge. It has a distinct striation consisting of a pattern of dark and transparent lines arranged obliquely from a central axis. Anterior to the muscular impression, the thickness of the shell is increased to form a thickened bar running in an umbonal-ventral direction and becoming obsolete towards the ventral edge. The umbonal-ventral ridge is distinct and segmented; it is slightly thickened ventrally, but the condyle is not visibly developed.

The mesoplax consists of two vertical plates. The anterior edge of the two plates forms an arch; they both touch at their upper third and diverge at their respective bases, which are rounded and laterally curved. The surface of the mesoplax shows a fine striation running parallel to the anterior (superior) edge.

The siphon is fairly large and (in contrast to all other species studied) it is in all specimens bent ventrally. It is rather thick walled and not covered by a periostracum; the incurrent opening has no cirri. The excurrent opening is rather close to the posterior edge of the shell and is likewise, without cirri. From the latter, a groove extends along the dorsal side of the siphon to the incurrent opening which is bound along both sides by low, rounded continuous walls. Owing to the contraction of the siphon at time of preservation, these are strongly folded. The posterior part of the mantle edge is thick and protrudes from the shell.

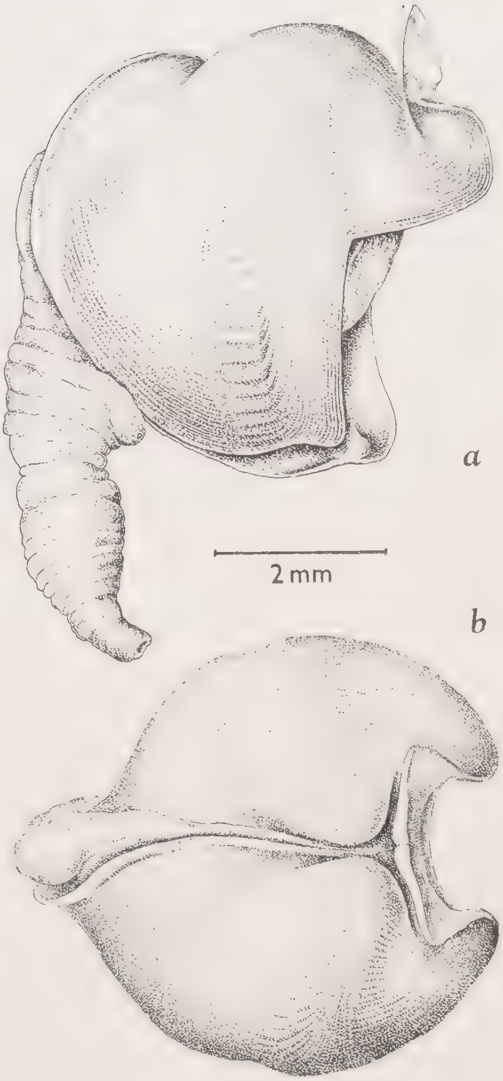


Fig. 24. *Xylophaga aurita* n. sp.; holotype; a, lateral view; b, dorsal view. P. H. W.

Dimensions of the type specimen:
Length: 5.4; height: 5.1; breadth: 5.2.

Reproduction: nothing known.

Affinities:

In the shell, particularly the posterior end, and in the vertical position of the mesoplax, the present species resembles *erecta* and *concava*. The shape of the mesoplax differs greatly from that of the two species just mentioned; in *concava* the mesoplax is semicircular, each plate having a broad base, while in *aurita* the base of the individual plate is narrow and laterally curved. The posterior muscular impression is similar to that of *washingtona* Bartsch, which, however, has an entirely different type of mesoplax and also differs in many other respects.

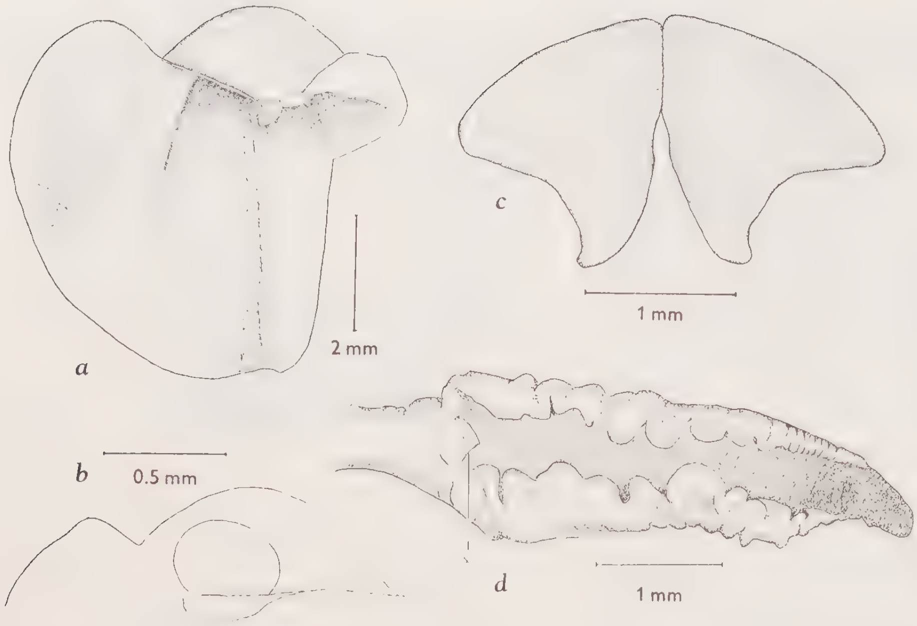


Fig. 25. *Xylophaga aurita* n. sp.; a, internal view of the left shell; b, outline of umbo and prodissoconch of the left shell; c, frontal view of the mesoplax; d, dorsal view of the siphon and the posterior part of the mantle. The excurrent opening is located at X; a-c, paratypes; d, holotype.

The siphon is of the type found in *dorsalis* (Turton) (PURCHON 1941) and in *globosa* Sowerby (TURNER 1955). In both these species the dorsal groove leading from the excurrent opening is bound by two rows of small lappets, while in *aurita*, the groove is bound by continuous walls. As already mentioned, the ventrally-directed siphon is not found in any other species of *Xylophaga* hitherto studied.

Xylophaga turnerae n. sp.

(Fig. 26, 27)

Material:

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST600. Bottom: green clay. Bottom temperature: about 5.0° C. – 1 specimen.

Diagnosis:

Xylophaga having a horizontal triangular mesoplax with curved basal parts, occupying about half the anterior incision. Siphon small and slender. Incurrent opening of the siphon with 9 cirri and a circular fold. Excurrent opening close to the base of the siphon and a groove running from this opening to half way down the siphon.

Description:

The shell is rather large and opaque. The umbo is prominent and has a posterior rounded ridge. The beak extends a little more than half the distance to the ventral edge of the shell. The breadth of the anterior incision is about one fourth the total breadth of the shell. The umbonal reflection is well developed, the posterior part adhering to the anterior part of the umbo. The ridges of the beak are fine and close-set, particularly on the ventral half. The umbonal-ventral sulcus is distinct and broad, bound on both sides by raised ridges. The anterior ridge is low, while the posterior is broader and much more prominent, being seen as a distinct curvature of the ventral edge of the shell. The oblique ridges of the anterior slope continue across the umbonal-ventral sulcus as distinct concentric ridges, which are subdivided into two or three finer striae. This sculpture becomes obsolete across the ridge posterior to the sulcus but re-appears on the posterior slope, becoming somewhat more indistinct when approaching the posterior edge of the shell. Interior of the shell: the posterior muscular impression is large and rounded and is without sculpture. Anterior to the muscular impression a rounded ridge is present which runs from the umbo to about half the distance to the ventral edge. The umbonal-ventral ridge is narrow, prominent and regularly segmented; a condyle is not present. Posterior to the umbonal-ventral ridge is a groove reflecting the external ridge posterior to the umbonal-ventral sulcus.

Mesoplax horizontal. Each plate is triangular, pointed posteriorly, and connected along the median edge. The lateral parts of each plate are ventrally bent, and the anterior edge forms a stump angle. The whole mesoplax occupies only about half the anterior incision.

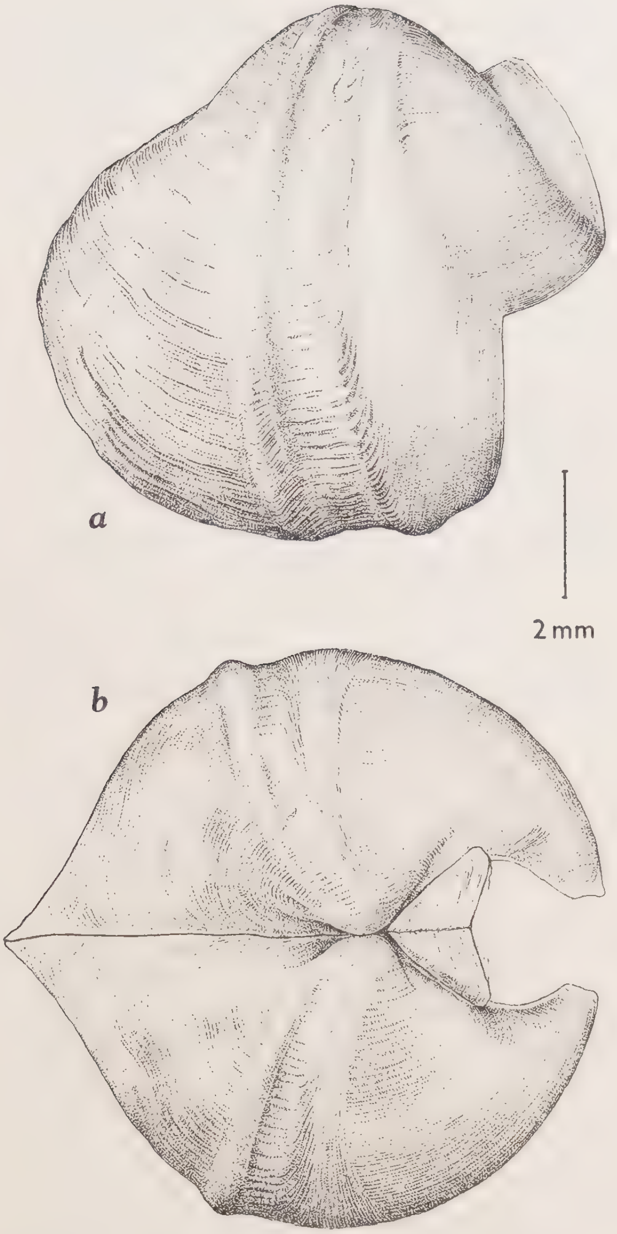


Fig. 26. *Xylophaga turnerae* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

The siphon extends about 5 mm from the posterior edge of the shell and is rather slender with a tapering distal end. The incurrent opening is surrounded by a collar-like fold which becomes obsolete ventrally. Inside the fold 9 cirri are present; each side has 4 short cirri, while a longer and more slender one is located dorsally in the median line. The excurrent opening is situated about 1 mm from the posterior end of the shell; this is a simple round hole on a small protuberance with no cirri present. From the excurrent opening a deep furrow bound by two prominent folds extends about half the length of the siphon. The extreme half of the siphon is almost circular in section with no trace of the dorsal groove.

Dimensions of the type specimen:
Length: 9.6; height: 8.5; breadth: 9.2.

Reproduction: nothing known.

Affinities:
The present species resembles *aurita* in the appearance of the siphon. Both species have the excurrent opening close to the base of the siphon and a distinct longitudinal groove on the dorsal side. In *aurita,* however, this groove extends to the distal end, while in *turnerae*, it is absent from the distal half of the siphon. In *aurita* the incurrent opening is without tentacles, while in *turnerae*, cirri surrounded by a skin fold are present. The two species differ greatly in the appearance of their mesoplaxes: in *aurita* the mesoplax is vertical, the individual plates are fanshaped and the posterior part is

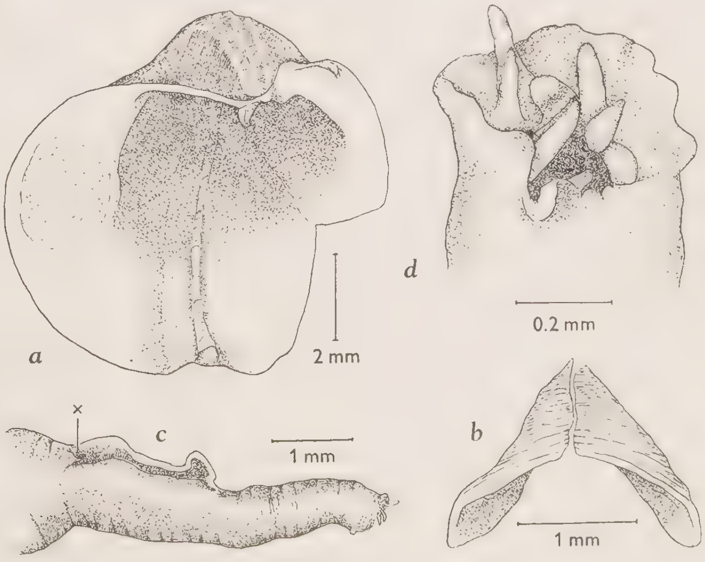


Fig. 27. *Xylophaga turnerae* n. sp.; a, internal view of the left shell; b, mesoplax dorso-frontal view; c, siphon seen from the left side; excurrent opening located at X; d, posterior end of the siphon.

pointed. In *turnerae* the mesoplax consists of triangular plates which are almost horizontal. A mesoplax similar to that of *X. turnerae* has been described in *atlantica* Richards (TURNER 1955, p. 153, pl. 91). In the latter the basal edge is reflected to form a small groove which contains part of the anterior adductor muscle, while in *turnerae*, no reflection of the basal edges of the mesoplax is found. In *atlantica* the siphon differs from that of *turnerae:* the excurrent opening being located much closer to the incurrent one and without a dorsal groove.

This species has been named after Dr. RUTH TURNER.

Xylophaga africana n. sp.

(Fig. 28)

Material:

St. 52, off West Africa (1°42'N, 7°51'E), 2550 m, 30. Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temperature: about 3° C. – 2 specimens. Both specimens are very damaged, the shells being so fragmented that a complete description is not possible. One specimen (selected as a type) had, however, the mesoplax preserved in situ, the right plate being somewhat damaged. In both specimens the soft parts were moderately well preserved.

Diagnosis:

Xylophaga with a simple mesoplax consisting of two triangular plates united along a short median line, forming an acute angle. The siphon is short. The aperture of the incurrent opening without cirri and about 6 short cirri round the excurrent opening. No lappets along the dorsal side of the incurrent siphon.

Description:

The shell. Only the dorsal and anterior parts of the shells of the two specimens are sufficiently well preserved to make a description possible: The umbonal reflection is well developed, somewhat recurved, but not adhering to the underlying part of the beak. Posteriorly, the reflection extends close to the prodissoconch, which, however, it does not cover. The prodissoconch is distinctly seen in the type: It has a length of about 0.3 mm and a pointed umbo.

The mesoplax. The two triangular plates are somewhat curved dorsally and have a short median line. In frontal view the two plates form a pointed arch. Both the anterior and the basal edges are practically straight. The dorsal surface has a fine striation running parallel to the anterior edge. The ventral surfaces of the plates are smooth with a small rounded nodule near the median line.

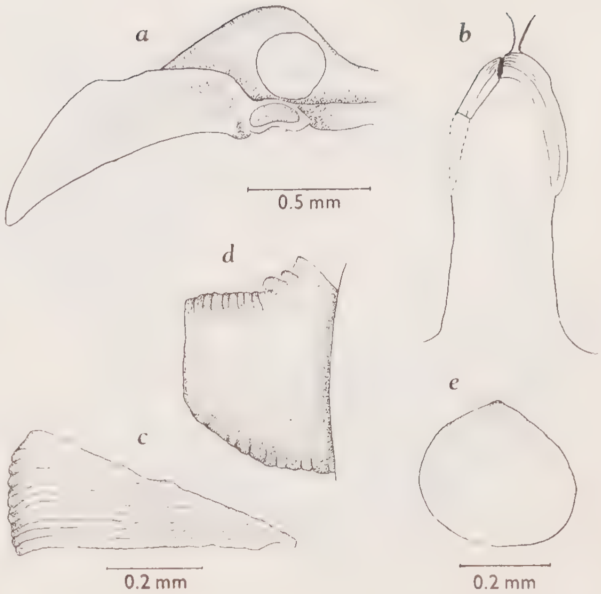


Fig. 28. *Xylophaga africana* n. sp.; a-c, holotype; a, umbonal part of the left shell; b, frontal view of the mesoplax; c, dorsal view of the left plate of the mesoplax; d, siphon of the paratype seen from the right side; e, shell of a juvenile from the holotype.

The siphon is short; it is almost completely retracted in the type, while in the paratype it extends a little more than 0.5 mm outside the shell. The incurrent siphon of this specimen is much larger than the excurrent siphon and has no cirri; the latter has 6 short cirri – 3 at each side.

Reproduction:

The type has 9 young fixed by means of a byssus to the dorsal part of the shell, immediately behind the umbo. The shells of the young are whitish, 350-375 μ in length and are shaped like the prodissoconch of the type specimen.

Affinities:

In the present species the plates of the mesoplax form an acute angle in the same way as in *Metaxylophaga supplicata,* Taki & Habe (1950). The present species clearly differs, however, from TAKI & HABE's species in the shape of the umbonal reflection: In *M. supplicata* the umbonal reflection is situated more ventrally than in *X. africana;* it is not reflected and does not extend to the vicinity of the umbo as is the case in the latter species. The figures of TAKI & HABE do not show in detail the shape and arrangement of the mesoplax, but it would appear that the plates are pointed dorsally and the ventral angle points obliquely downwards, while in *africana* it is directed almost ventrally. There are no other species with a mesoplax similar to the two species mentioned here. The siphon of *africana* is similar to that of *X. atlantica* Richards described and figured by Turner (1955). In this species the excurrent siphon is located at some distance from the incurrent siphon and has 6-8 large cirri. – The mesoplax in *atlantica* is, however, completely different from that of *africana*. It is triangular, with a long median line and a reflected lateral part. A similar type of siphon was described, but not figured, by Turner (1956), for *washingtona* Bartsch. The mesoplax of that species, described and figured by Turner (1955, p. 155, pl. 92, figs. 4-6) is very similar to that of *atlantica* Richards and very different from *africana*.

Xylophaga wolffi n. sp.
(Fig. 29, 30)

Material:

St. 444, Sulu Sea (7°54'N, 121°30'E), 5050 m, 17. Aug. 1951. Gear: HOT. Bottom: mud. Bottom temperature: 10.6° C. – 2 specimens. Both were somewhat corroded and slightly damaged.

Diagnosis:

Xylophaga with a mesoplax consisting of two triangular plates forming an angle. The basal edge of each plate with irregular denticles. Siphon short. Incurrent opening surrounded by small cirri. Excurrent opening at the base of the siphon with two lateral groups of tentacles.

Description:

The shell is large with a prominent umbo. The beak extends less than half the distance to the ventral edge of the shell. The anterior incision is rounded, the maximum breadth being about one fourth of the total breadth of the shell. The umbonal reflection is small; its postero-dorsal edge has 7-8 small, irregular denticles. The prodissoconch is not visible. The ridges of the beak are rather broad. Dorsally, they are widely separated; the distance between the ribs being about twice the breadth of a rib. Towards the ventral edge the ribs gradually become more close-set. The umbonal-ventral sulcus is shallow and has a distinct central groove. The oblique ribs of the anterior slope become separated towards the sulcus, and anterior to the latter, they form faint nodules; from here the concentric sculpture commences. This consists of rather regular ribs which are narrow across the sulcus; posterior to the latter they become somewhat broader. The individual ribs show a finer striation each rib having 3-4 striae. Towards the posterior end of the shell the ribs gradually become obsolete and are transformed into an irregular but distinct striation. Interior of the shell: The posterior muscular impression is indistinct, pear-shaped, extending about half the distance to the ventral edge of the shell; it has a rather indistinct oblique striation. The umbonal-ventral ridge appears as a flat, regularly segmented band without a condyle.

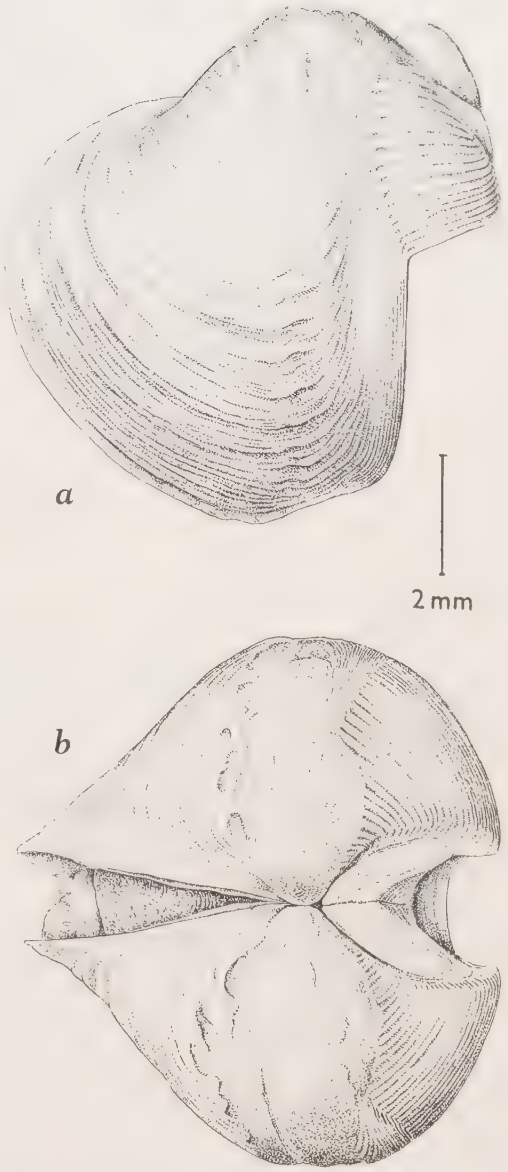


Fig. 29. *Xylophaga wolffi* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

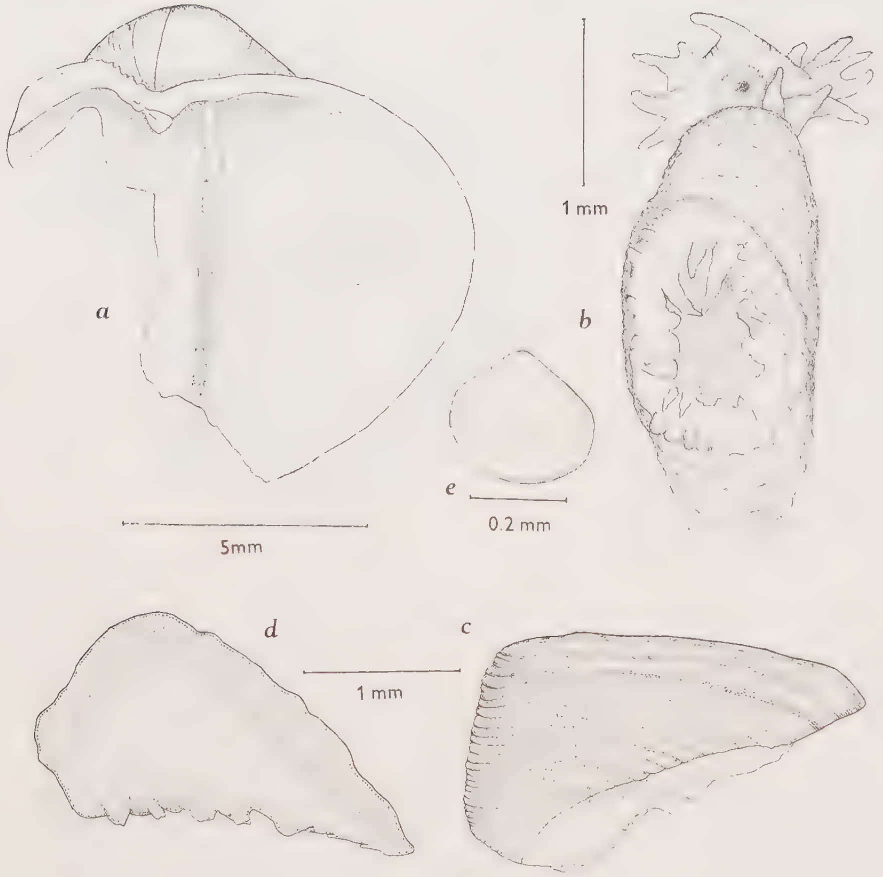


Fig. 30. *Xylophaga wolffi* n. sp.; a-d, paratype; a, internal view of the right shell; b, siphon seen from behind; c, dorsal view of the right plate of the mesoplax; d, ventral view of the same plate; e, juvenile from the holotype.

The mesoplax consists of two triangular plates, having a short median edge. The basal edge has 6-8 flat denticles which fit into the denticles of the edge of the umbonal reflection already referred to. The dorsal surface of each plate has a regular striation running parallel to the anterior edge. The ventral surface is somewhat thickened along the basal and anterior edges. In both specimens the two plates form an acute angle in frontal view.

The siphon is short and thick-walled. In the type specimen it is completely retracted within the shell; in the paratype it extends 2-3 mm beyond the posterior edge of the shell. The incurrent opening is relatively large and has some 30 small cirri surrounding it. The excurrent opening is located close to the base of the siphon. At each side there are about 7 finger-like tentacles on a common base and in addition, a somewhat larger tentacle dorsally.

Dimensions of the type specimen:
Length: 8.5; height: 8.9; breadth: 8.9.

Reproduction:

Uncleaved eggs were found in great numbers in the gonad of the paratype. The exact number cannot be stated since many eggs were lost when the specimen was being handled. The diameter of the eggs was about 0.07 mm. Both specimens had juveniles attached. The type had 2 juveniles on the dorsal part of the shell posterior to the umbo. In addition, 2 juveniles were fixed to the mantle edge, one about midway between umbo and siphon the other located close to the siphon. In the paratype 4 juveniles were found adhering to the siphon, each in a small pit. The shell lengths of the juveniles varied between 2.8 and 3.1 mm. The juveniles had rounded shells without any trace of a beak. The soft parts, however, had the general appearance of a typical *Xylophaga.*

Affinities:

The present species would seem to be similar to *Metaxylophaga supplicata* Taki & Habe. Both species have a triangular mesoplax, the plates of which form an acute angle. In the latter, however, there are no denticles along the basal edge of each plate, and likewise no denticles are found along the dorsal edge of the umbonal reflection. The two species seem to differ also in the shape of the umbonal reflection and in the general outline of their shells.

TAKI & HABE do not refer to the siphon of their species, thus, no comparison can be made of this important character. Among the species of the present material, *wolffi* seems to be related to *africana.* The mesoplax is of the same type; the two plates being triangular in shape with a short median edge, but again there are no denticles in *africana.* The two species also differ in the shape of the umbo and umbonal reflection. Further they have the same type of siphon, but there are marked differences in the arrangement of the tentacles.

The species has been named after T. WOLFF, Ph. D., first scientist of the *Galathea.*

Xylophaga bruuni n. sp.

(Fig. 31, 32)

Material:

St. 443, Mindanao Sea (8°48'N, 124°09'E), 1500 m, 16. Aug. 1951. Gear: St. 300, D 45, D 80. Bottom: mud, many fragments of plants. – 1 specimen.

Diagnosis:

A *Xylophaga* having a mesoplax consisting of triangular plates with a short median edge. The median part of each plate is curved and each has a forwardly-directed, small tube. Siphon short and pointed, incurrent opening with about 10 cirri.

Description:

The shell is rather large and opaque. The umbo is prominent and has a faint rounded edge on the posterior part. The beak extends a little less than half the distance to the ventral edge of the shell. The breadth of the anterior incision is about one fourth the breadth of the shell. The umbonal reflection is well developed, adhering to the rest of the shell at the anterior part of the umbo. Prodissoconch could not be observed. The ridges of the beak are close-set. Near the umbo the interstices are, at most, double the breadth of the ridge, but near the ventral edge only about half as broad as the ridges. The umbonal-ventral sulcus is shallow and without ridges or central groove. The region around the sulcus has a regular concentric sculpture continuing the oblique ridges of the anterior slope. The concentric sculpture becomes irregular and less conspicuous posterior to the sulcus. Interior of the shell: the posterior muscular impression is rather large, located dorsally, and close to the posterior edge; it shows a rather distinct radiating striation. Anterior to the muscular impression is a distinct edge running from the umbo about half the distance to the ventral edge of the shell. The umbonal ventral ridge is very indistinct, except close to the ventral edge.

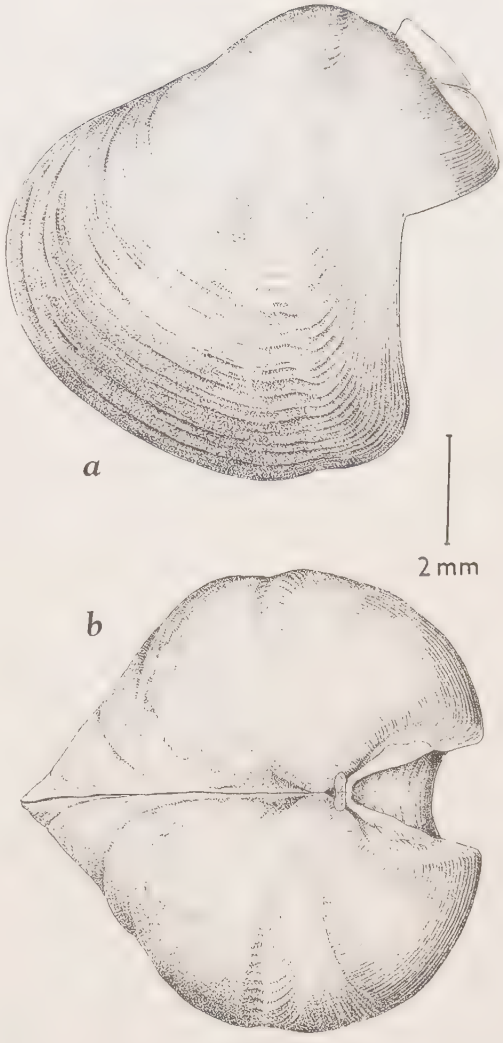


Fig. 31. *Xylophaga bruuni* n. sp., holotype; a, lateral view of the right shell; b, dorsal view. P. H. W.

The mesoplax consists of two triangular plates situated at an acute angle to each other. The median edge is short, the basal edge long and straight, and the anterior edge is slightly convex. Each plate has a small forward directed tube located posteriorly and close to the median edge; the median part of each plate is bent at an almost right angle.

The siphon is short and strong with a tapering distal part; the total length being only about 3 mm. It is completely retracted within the shell, bent dorsally, and is unfortunately somewhat damaged. It is, however, possible to observe that the incurrent opening is surrounded by about 10 cirri, the two dorsal ones being the largest. The cirri are located inside an undulating fold. The excurrent

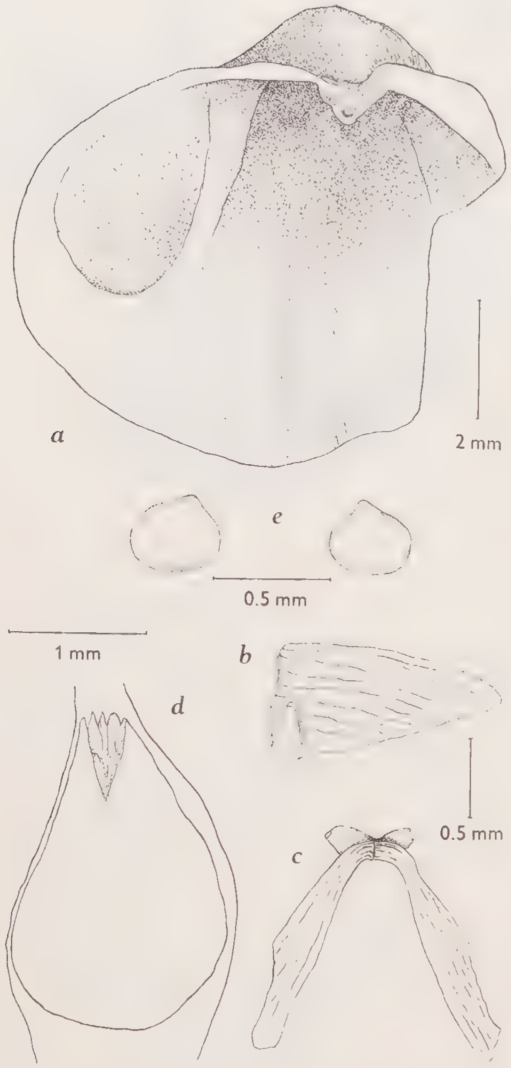


Fig. 32. *Xylophaga bruuni* n. sp., holotype; a, internal view of the left valve; b, dorsal view of the right plate of the mesoplax; c, frontal view of mesoplax; d, siphon seen from behind. The siphon is dorsally reflected so that the exhalant opening with its surrounding tentacles is seen above; e, two juveniles.

opening cannot be studied owing to damage, but it is possible that it is located at the base of the siphon, where, what are presumably a few cirri, have been observed.

Dimensions:
Length: 10.0; height: 9.5; breadth: 8.0.

Reproduction:
On the postero-dorsal part of the shell four small juveniles have been found. They have a very prominent umbo. The total lengths are 0.35 to 0.4 mm.

Affinities: see p. 194.
The species has been named after A. F. Bruun D. Sc., Leader of the *Galathea* Expedition.

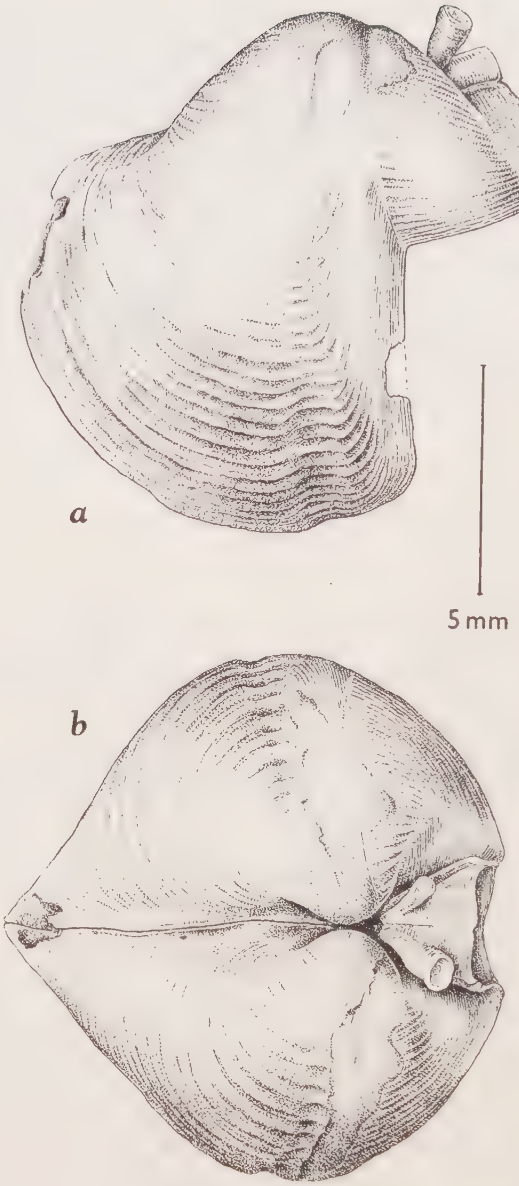


Fig. 33. *Xylophaga tubulata* n. sp., holotype; a, lateral view of the right shell; b, dorsal view.
P. H. W.

Xylophaga tubulata n. sp.

(Fig. 33, 34)

Material:
St. 453, Makassar Strait (3°56'S, 118°26'E), 2000 m, 24. Aug. 1951. Gear: ST 300. Bottom: clay Bottom temperature: 3.6° C. – 1 specimen.

Diagnosis:
Xylophaga having a horizontal mesoplax with bent basal parts and two relatively large, trumpet shaped tubes. The shell with a distinct concentric sculpture.

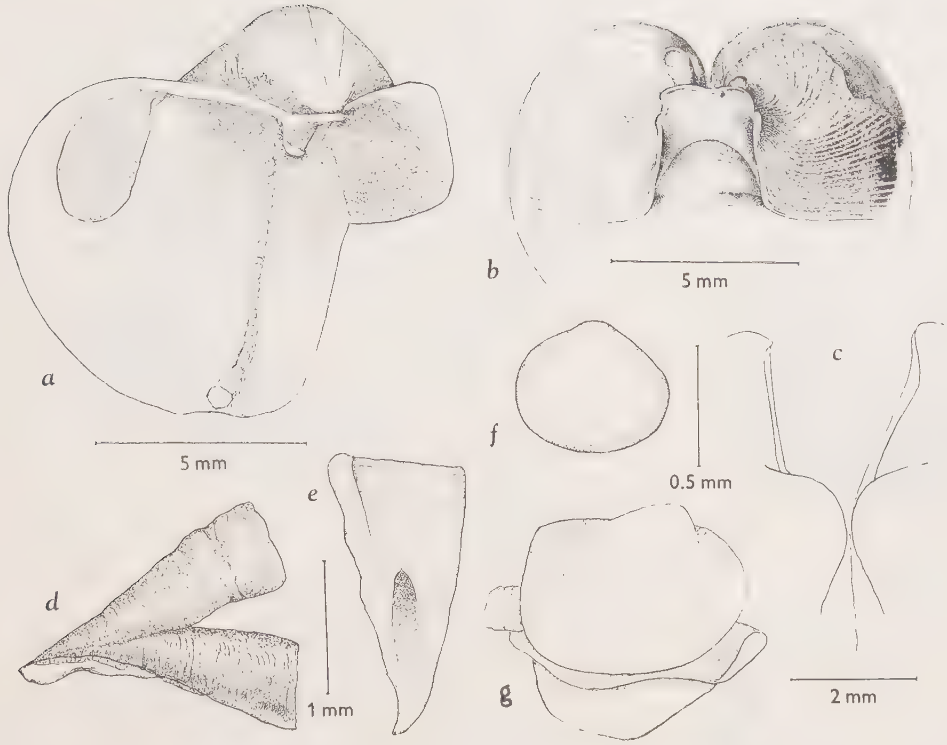


Fig. 34. *Xylophaga tubulata* n. sp.; a, internal view of the left shell; b, frontal view of the dorsal part of the shell. P. H.W.; c, dorsal view of the anterior incision; d, lateral view of the right plate of the mesoplax, below: the plate proper, above: the tube; e, ventral view of the right plate of the mesoplax showing the interior opening of the tube; f, juvenile shell; g, larger juvenile with well developed foot and siphon.

Description:

The shell is large and opaque with a prominent and rounded umbo. Seen from the dorsal side the posterior end has a slightly concave outline. The beak extends a little less than half the distance to the ventral edge of the shell. The lateral edges of the anterior incision are almost straight; the maximum breadth, which is close to the anterior edge of the shell, is about one fourth of the total breadth of the latter. The umbonal reflection is well developed, triangular. The ridges of the beak are widely spaced at the umbo – the interstices being about twice the breadth of a ridge. Towards the ventral edge of the beak the interstices gradually become more narrow. The umbonal-ventral sulcus is a shallow depression without ridges or a central groove. The oblique lines of the anterior slope continue as regular, well developed concentric ribs on the posterior part of the shell. These concentric ribs are somewhat nodulose on both sides of the umbonal-ventral sulcus and flattened across the latter. On the posterior slope the ribs are sharp, aequidistant, and have narrow interstices. Interior of the shell: the posterior muscular impression is relatively small, pear-shaped, located dorsally, and without sculpture. The umbonal-ventral ridge is prominent, narrow, and distinctly segmented; no condyle is present.

The mesoplax consists of two triangular plates which are bent longitudinally at a right angle. The median edge has the same length as the mesoplax. The posterior end of each plate is pointed and slightly divergent. Each plate has a large forward directed tube. The tube of the left plate is damaged; that of the right plate extends to the anterior edge of the plate. It is trumpet shaped and has a large circular external opening covered with conchiolin. The internal opening of each tube is a comparatively large, longitudinal slit.

The siphon: The distal part is obviously missing, it is impossible, therefore, to give any information on this important character.

Dimensions:

Length: 12.0; height: 11.0; breadth: 12.0.

Reproduction:

At the ventral base of the siphon 5 embryos were found in a depression of the mantle tissue. One embryo had a shell length of about 1 mm, while the others were only about 0.6 mm long. In all embryos the shells are rounded and neither beak nor mesoplax is developed. The soft parts, however, show the characteristic foot of a *Xylophaga*. In the large embryo the foot projects from the ventral part of the shell; the mantle has two anterior lobes, and a small siphon. It could be observed that also the small embryos had the typical foot of a *Xylophaga*, but otherwise no details of the anatomy could be observed.

Affinities: see p. 194.

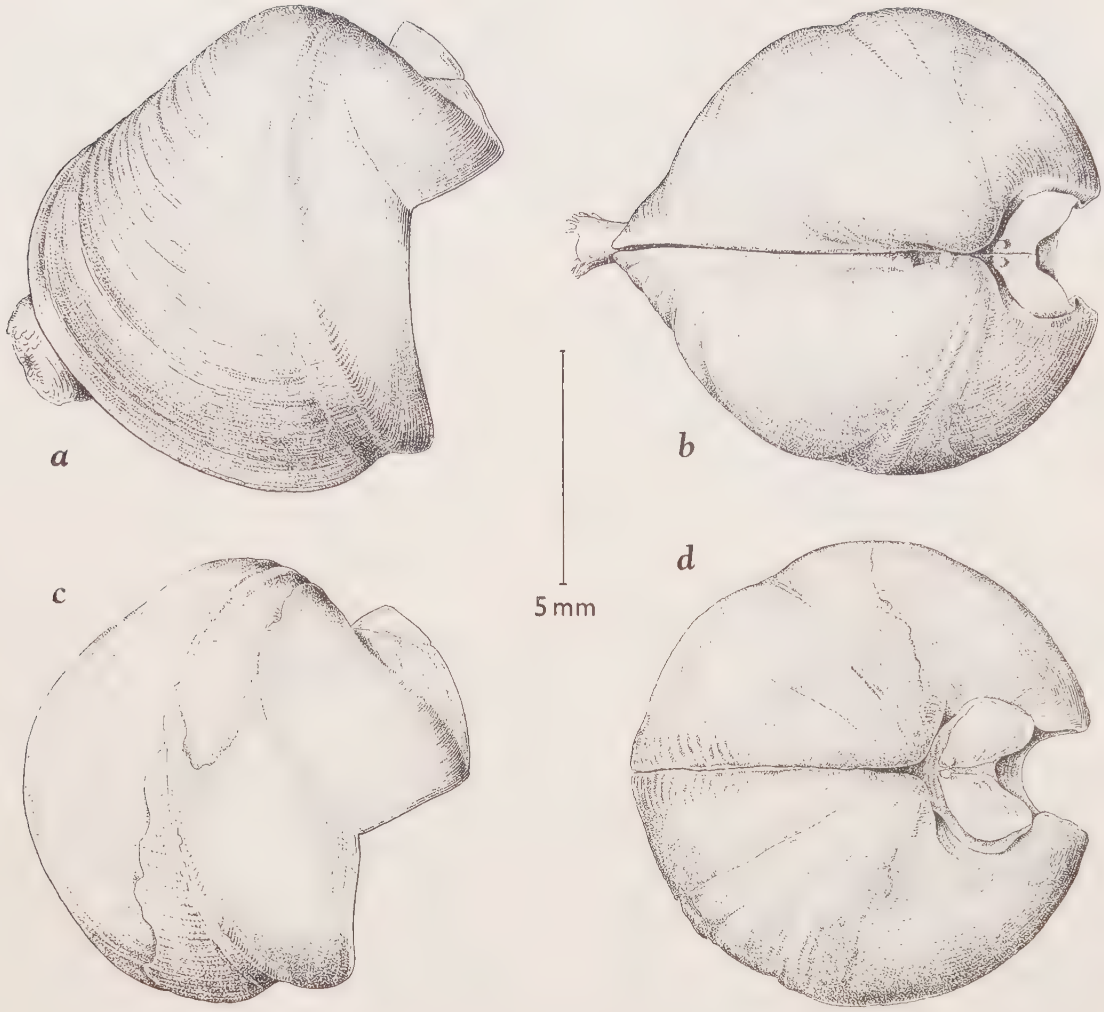


Fig. 35. *Xylophaga obtusata* n. sp.; a, lateral view of holotype; b, dorsal view of holotype. Note the two small juveniles posterior to the umbo; c, lateral view of paratype; d, dorsal view of paratype. P. H. W.

Xylophaga obtusata n. sp.

(Fig. 35, 36)

Material:

St. 745, Gulf of Panama (7°15'N, 79°25'W), 915 m, 16. May 1952. Gear: ST 600. Bottom: green clay. Bottom temperature: about 5.0° C. – 2 specimens.

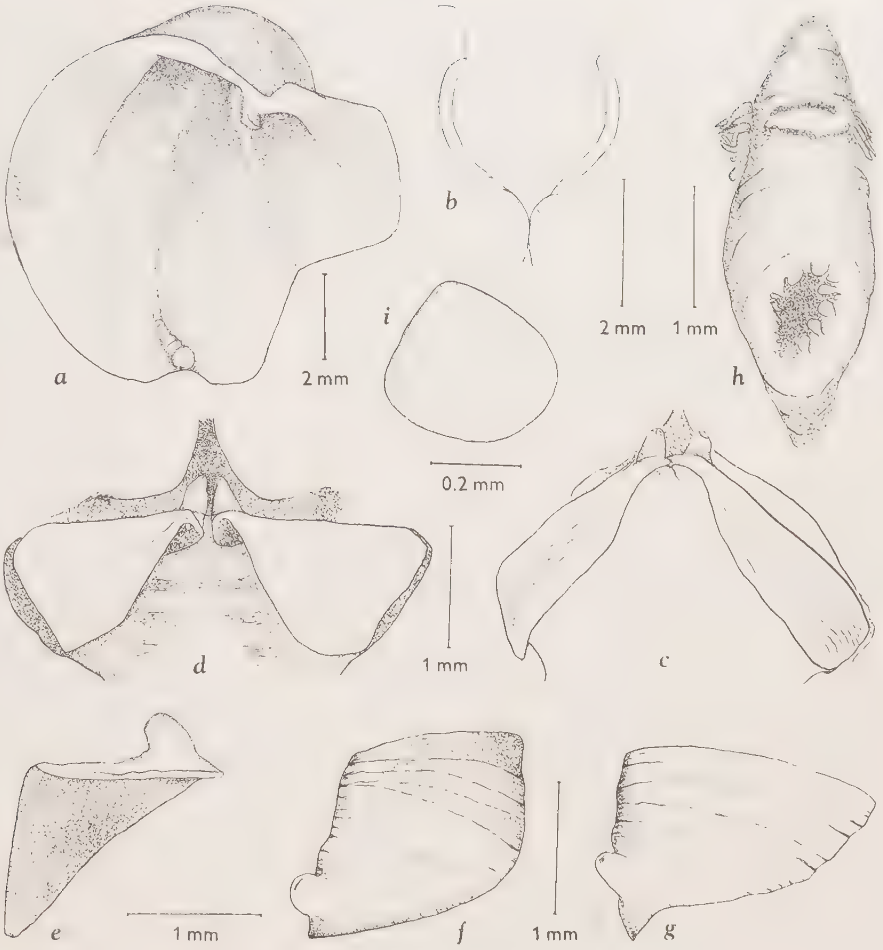
Diagnosis:

Xylophaga with small tubes on the mesoplax, a short solid siphon; the excurrent opening of which has lateral bundles of slender cirri, while the incurrent opening is surrounded by about 15 small and globular cirri.

Description:

The shell is rather large with a low, rounded apex. In the type the outline of the posterior part of the shell, seen from the dorsal side, forms two almost straight lines at a right angle to each other. The paratype has a somewhat different shape, being practically globular. In the type the beak extends a little less than half the distance to the ventral edge of the shell, while in the paratype it extends much further down. The umbonal reflection is rather large and triangular. The ventral edge of the beak forms an obtuse angle with the anterior edge of the shell. The anterior incision is rounded, its largest breadth forming about $^{1}/_{3}$ the breadth of the shell. The prodissoconch cannot be seen. The ridges of the beak are very close-set all over. The umbonal-ventral sulcus is well developed and its shape is reflected as a pronounced curvature of the ventral edge of the shell. The sulcus has a distinct median groove and is bound anteriorly by a faint but distinct ridge. The sulcus and its anterior ridge have a rather regular sculpture of concentric ridges, which are continuations of the oblique ridges of the anterior slope.

Fig. 36. *Xylophaga obtusata* n. sp.; a, internal view of the left shell of paratype; b, anrior incision of paratype; c, frontal view of the mesoplax of the holotype; d, frontal view of the mesoplax of paratype; e, right plate of the mesoplax of the holotype seen from the inside, the anterior edge being to the left; f, dorsal view of the right plate of the mesoplax of paratype; g, dorsal view of the right mesoplax of the holotype; h, siphon seen from behind, paratype.



Posterior to the umbonal-ventral sulcus this sculpture disappears gradually, being replaced by a very fine irregular, concentric striation. Interior of the shell: The posterior muscular impression is large, elliptic and located close to the postero-dorsal edge of the shell. It has a distinct striation radiating from an area at the anterior edge of the muscular impression. Anterior to the latter a distinct ridge runs from the umbo to about half way down the shell, where it gradually becomes obsolete. The umbonal-ventral ridge is rather indistinctly demarcated except in the ventral fourth. The segmentation is irregular and not very pronounced. Condyle is faintly demarcated. The separation between the beak and the anterior slope appears internally as a distinct ridge.

The mesoplax: The median edge of each plate is straight and about half the total length of the plate. Each plate has a small tube located posteriorly and close to the median edge. The shape of the plates differs somewhat in the two specimens. In the type the basal edge is slightly curved and the anterior edge is much longer than the median edge. Whereas, in the paratype the basal edge is strongly curved and the anterior edge is about the same length as the median edge. Further, in the latter specimen the anterior part of the plate is ventrally bent, forming 2 pronounced lobes, while the remaining part of the plate is approximately horizontal. In the type specimen, however, the anterolateral part of the plate is not ventrally bent and the two nearly flat plates are situated almost at right angles. In view of this, the mesoplaxes of the two specimens look rather different in situ. However, when the plates are removed from the shells it is quite obvious that the two specimens have the same type of somewhat varying mesoplax. The tubes are anteriorly directed, rather small. The external openings are small and the internal openings are longitudinal slits.

The siphon: In the type the siphon extends about 1.5 mm from the edge of the shell, while in the paratype the whole siphon is drawn inside the shell. The two openings are rather close together; the incurrent opening is thickwalled and surrounded by about 15 small cirri. The excurrent opening is a transverse slit with a distinct ventral lip and situated on each side, are clumps of small pointed cirri. The left clump has 9 cirri but the right is obviously damaged and only 5 cirri remain.

Dimensions of the type specimen:
Length: 10.0; height: 10.1; breadth: 10.0.

Reproduction:
In the type specimen two embryos were found attached to the postero-dorsal part of the shell, close to the umbo. These had small rounded shells about 0.33 mm in maximum length.

Affinities:
The three species *bruuni, tubulata* and *obtusata* differ from all other species of *Xylophaga* hitherto described, by having tubes on the dorsal surface of the mesoplax. *X. tubulata* has large tubes and a horizontal mesoplax, while in the two other species the tubes are much smaller and the mesoplax quite different. In *tubulata* the shell has a rather coarse concentric sculpture and the posterior muscular impression is relatively small. The shells of the two other species are rather smooth. In *bruuni* the posterior muscular impression is large and pear shaped while in *obtusata* it is much more narrow. The three species differ further in the shape of the anterior incision and the siphons of *bruuni* and *obtusata* are widely different.

Xylophaga indica E. A. Smith, 1904
(Fig. 37)

Xylophaga indica E. A. Smith, 1904, p. 7; E. A. Smith 1907, pl. XVII, fig. 3, 3a.

Original description:
Testa *X. dorsali* similis, sed valvis sulco mediano aequaliter bipartitis, lira interna aeque centrali.

Remarks:
No figures accompanied the first description but ater (1907) Smith did figure the species. The species is not found in the material of the *Galathea* Expedition, but during a stay at the British Museum (Nat. Hist.), London, the author had the opportunity of examining Smith's material. This is comprised of one complete specimen containing the dried up soft parts and two shells. This material was obtained by the *Investigator* Expedition St. 233, 13°17'15"N, 93°10'E, off Andamans, 185 fathoms (339 m). The bottom is reported to consist of sand but no mention is made as to the occurence of any plant material at the station.

In *indica* the beak of the anterior slope extends more than half the height of the shell and has a dense striation of fine ridges. The umbonal reflection is relatively large and extends to the anterior end of the beak. Posteriorly, it is developed into two rounded lobes partly covering the umbo. The umbonal-ventral sulcus is well developed and delimited by two distinct ridges. Inside the shell the posterior muscular impression is easily seen; it is fairly large, oval and located at the edge of the shell. In the complete specimen the prodissoconch and the mesoplax were present; the former having a length of about 0.6 mm. The mesoplax consists of two plates which are separated in their proximal parts but joined in their distal half. The individual plate is oblong pear-shaped. The proximal parts are laterally bent and the proximal halves of the lateral parts are bent ventrally, forming a prominent curved ridge.

In his description Smith (1904) states that the present species is "very like *dorsalis,* but the valves are more equally divided down the middle by the central groove so that the anterior and posterior portions are about equal. In *dorsalis* they are decidedly unequal, the posterior side being conspicuously larger. – – The sculpture on the anterior areas and the protoplaxes are similar in both forms". – *X. indica* also resembles *dorsalis* in the shape of the umbonal reflexion and the posterior muscular impression. The mesoplaxes are, however, rather different; in *dorsalis* it is almost semicircular with a

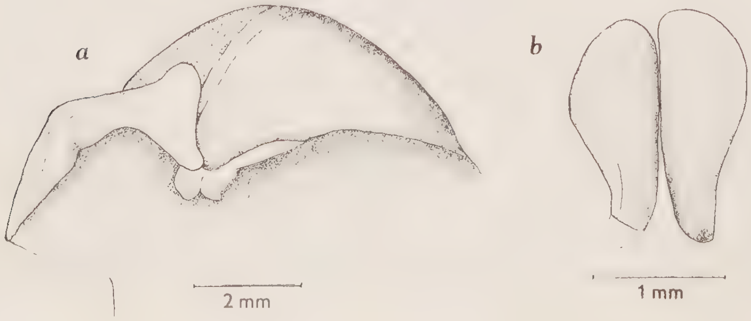


Fig. 37. *Xylophaga indica* E. A. Smith from the Bay of Bengal; a, umbo and umbonal reflection of a right valve; b, dorsal view of the mesoplax.

long curved anterior edge. Likewise the umbonal-ventral sulcus in *dorsalis* does not possess the two distinct ridges found in *indica*. It would seem that *indica* is quite distinct from *X. dorsalis*. *X. globosa* Sowerby has a long beak and distinct ridges at the umbonal-ventral sulcus, as found in *indica*; but in the former species the mesoplax is different and bears some similarity to that of *dorsalis*.

The complete specimen referred to above is assigned as the lectotype. It has the following dimensions: Length: 12.0; height: 12.1; breadth: 12.0.

Xylophaga guineensis n. sp.

(Fig. 38)

Material:

St. 52, off West Africa (1°42'N, 7°51'E), 2550 m, 30. Nov. 1950. Gear: SOT. Bottom: muddy clay. Bottom temperature: about 3.0° C. – The material consists of the very fragmented shells of 5-6 individuals removed from a piece of wood: not a single complete shell is present. In one case the complete mesoplax is in situ, indicating that the species is probably living in the locality. No trace of soft parts has been observed. The specimen with the mesoplax preserved is selected as the type.

Diagnosis:

Xylophaga having a horizontal triangular mesoplax with sharply bent basal parts, and ventrally curved at the proximal end. Prodissoconch large, distinctly marked off and of a bright yellowish colour.

Description:

No description of a complete shell is possible as the available material consists of the umbonal parts of shells only. The dorsal reflection of the beak is well developed and reflected, but it does not adhere to the underlying part of the beak: in its proximal part it covers a small area of the umbo and the prodissoconch. The latter is rather big and almost circular and is very distinctly marked off from the adult shell. It is about 0.6 mm in length and is of a very bright yellow colour. A very fine and dense concentric striation covering the whole prodissoconch can be seen under the microscope. In the much damaged adult shells it could be observed that the umbonal-ventral sulcus is not very deep; it is bound by two rounded ridges, the posterior being slightly more prominent than the anterior. The posterior part of the shell has a fine sculpture consisting of irregular, fine growth lines.

The mesoplax is horizontal and has the lateral parts curved at a right angle to the remaining parts of the plates. The proximal parts of the mesoplax are ventrally curved. The dorsal surface is slightly concave and the left plate of the mesoplax is slightly larger than the right one. The siphon is unknown.

Affinities:

The present species is clearly different from *africana*, described above from the same locality. Marked differences can be observed in the umbonal reflection, size, shape and colouration of the prodissoconch and the mesoplax. A mesoplax having the lateral parts reflected in a similar man-

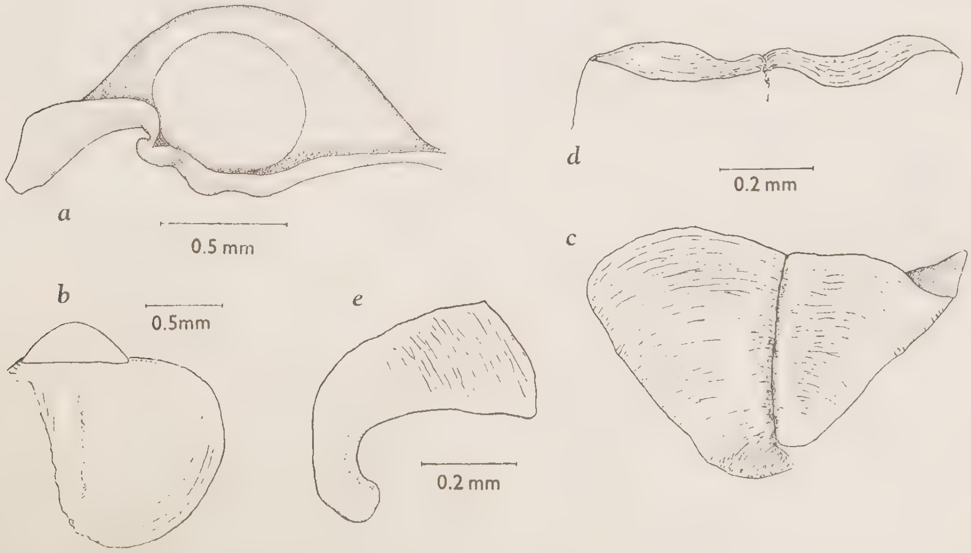


Fig. 38. *Xylophaga guineensis* n. sp., paratype; a, umbonal part of right shell; b, lateral view of left shell; c, dorsal view of mesoplax; d, frontal view of mesoplax; e, lateral view of mesoplax.

ner as in the present species has been described in two species viz. *atlantica* Richards and *washingtona* Bartsch (Turner 1955, p. 152, pl. 91, and p. 155, pl. 92). However, the shape of the plates differs in these two species, added to which, they are not curved proximally as in *guineensis,* and are not concave at their dorsal surface. A prodissoconch of the characteristic appearance observed in the present species seems to be unknown in the species of *Xylophaga* hitherto described, although Turner (1956), mentions that *washingtona* Bartsch has a very prominent golden-brown prodissoconch.

Xylophaga tomlini Prashad, 1932
(Fig. 39a-b)

Xylophaga tomlini Prashad, 1932, p. 317, pl. VII, fig. 9, 10.

Original description:

"*Xylophaga tomlini* is closely allied to *X. praestans* Smith, but the new species has a comparatively much smaller and thinner shell. The sculpture of its anterior triangular plate differs from that of *X. praestans* in the much larger number of closely situated, parallel, raised lines, the absence of the "lunule-like" space, the more strongly developed keel and the much more incurved umbones. The protoplaxes or the dorsal accessory plates are missing. The internal rib is well developed, but is not so strong as in *X. praestans.* The shells are of a dirty, yellowish-white colour. Measurements of holotype: – Length 16 mm, height 15 mm, diameter 14 mm."

Remarks:

This species is not found in the material of the *Galathea* Expedition but was obtained by the *Siboga* Expedition St. 88, 0°34'6"N, 11°8.5'E, 1301 m and is hitherto the only record of the species. Only one specimen was found. Prashad's description is very brief; his two figures show the external sides of the two shells but there are no details of the umbonal part. Hence, a more detailed description, including some figures will be given below. The present author has had the opportunity of borrowing the material of the species from the Zoologisch Museum, Amsterdam; this consists of the two shells figured by Prashad. Unfortunately the mesoplax is missing (as already mentioned by Prashad). On the interior surface of the shell some dry remains of the soft parts were still present, indicating that a complete animal had been obtained.

The beak is very large, extending more than half the total length of the shell. The umbonal reflection narrow and adheres posteriorly to the umbo. The anterior incision is rather broad and the prodissoconch not visible. The beak has numerous, close-set, fine ridges running parallel to the ventral edge, anteriorly curving upwards. The dorso-ventral sulcus is broad and deep: anteriorly, limited by a broad rounded ridge rather distinctly marked off from the rest of the shell. The posterior part of the shell has irregular, faint growth lines continuing across the dorso-ventral sulcus where they form irregular wrinkles; these are particularly distinct on the anterior slope of the sulcus.

The dorso-ventral sulcus is very well developed, being very distinctly marked off anteriorly, much less so posteriorly. The posterior muscular impression large.

In spite of the fact that neither the mesoplax nor the siphons are present, the present author is convinced that *tomlini* is a good species, clearly distinct from any other species previously described. It is

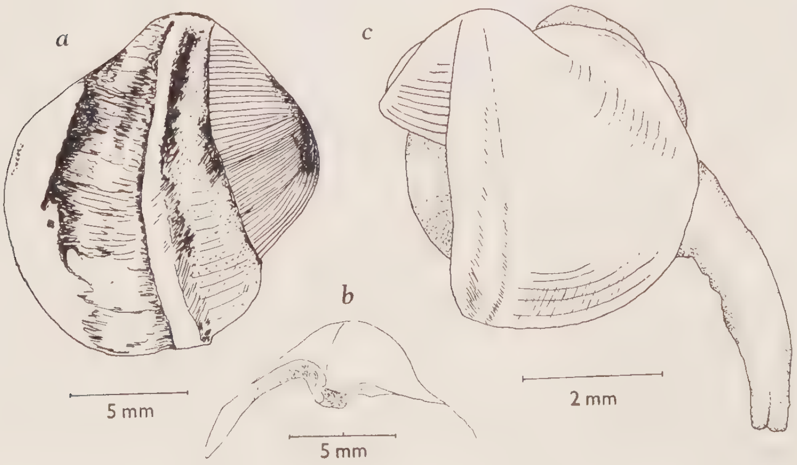


Fig. 39. a-b, *Xylophaga tomlini* Prashad; a, lateral view of the right shell; b, umbonal part of the right shell seen from the inside; c, *Xylophaga* sp. a after the drawing by Prashad (1932); c, after the drawing by Pelseneer (1911).

especially distinguishable by its large beak – which is larger than in any other known species of *Xylophaga*, by the deep dorso-ventral sulcus with a rounded ridge and by the appearance of the dorsoventral ridge of the interior side of the shell.

Xylophaga sp.

(Fig. 39c)

Xylophaga aff. *globosa* Pelseneer, 1911, p. 69, pl. 23, fig. 10, 11.

Remarks:

Pelseneer (1. c.) gave an account of the anatomy of a species of *Xylophaga* which was apparently never properly described. Pelseneer did not name the species (it was dredged by the Siboga Expedition), and no mention is made about the locality. This is, apparently, somewhere in the Indo-Malayan waters; the only information is a mention that it comes from "la Zone abyssale". Pelseneer gives a figure of a specimen seen from the left side, and this has been redrawn in the present paper. It appears that the species has a rather low umbo, the posterior part of the shell seems to have a concentric sculpture. No mention is made of the mesoplax. The siphon is long and slender, having both openings at the tip. The postero-dorsal part of the mantle protudes beyond the shell. The species was not referred to by Prashad (1932), who mentioned only one species of Xylophaga: *X. tomlini*. The present species would, however, seem to be quite different from *tomlini*, as is apparent from the figures of the two species given here. The two species differ greatly in the outline of the shells, the shape of the umbo, the shape and relative size of the beak and in the striation of the latter.

E. GENERAL REMARKS

Taxonomy

Xylophaga has generally been considered a genus within the family Pholadidae, which is characterized by having one or several accessory plates attached to the dorsal part of the shell. All the genera of the family are boring forms. Thiele (1935) divided the Pholadidae into two subfamilies, Pholadinae and Martesiinae; *Xylophaga* was placed in the former of the two. Purchon (1941) came to the conclusion that *Xylophaga* should be considered a family in its own right, Xylophaginidae, which he considered to be closer related to the Teredinidae than to the Pholadidae, although a number of affinities with both the Teredinidae and the Pholadidae were found. The following characters are enumerated as being peculiar to the Xylophaginidae: No apophysis, the pedal retractor shows primitive conditions, being inserted immediately anterior to the posterior adductor; reduction of the excurrent siphon, faecal accumulation ("chimney"), vesiculae seminalis, and the presence of an accessory genital organ. Turner (1954, 1955), considered *Xylophaga* to be a genus belonging to the Pholadidae, but further regarded it as a special subfamily, Xylophaginae, a division later adopted by Franc (1960). Turner's arguments for retaining *Xylophaga* within the Pholadidae are the presence of accessory plates, formation of a chimney (found also in *Parapholas)*, and the lack of apophyses. Turner (1955) found that one species studied, *X. atlantica* Richards, had practically no reduction of the excurrent siphon, and concludes that this character cannot be used as an argument for removing *Xylophaga* from the Pholadidae. It should be noted that also *Xylophaga* sp. mentioned and figured by Pelseneer (1911), has no reduction of the excurrent siphon.

Only very few attempts have been made to subdivide *Xylophaga*. Taki & Habe (1945) followed Purchon's suggestion of erecting a family Xylophaginidae. Besides the genus *Xylophaga*, to which they refer a new species, *rikuzenica*, they established a new genus, *Protoxylophaga*, the type species being *X. tomlini* Prashad. The authors separated this genus from *Xylophaga* by the following characters: (1) The beak extends ventrally close to the ventral edge of the shell. (2) The ridges of the beak are very numerous. (3) The anterior slope has no longitudinal lines (the "oblique lines" of the present paper). (4) The shape of the shell is high and not very long in antero-posterior direction. On account of these characters, the authors consider the species a primitive form compared to the other members of the group. Unfortunately, the authors did not have an actual specimen at their disposal but had to draw their conclusion from Prashad's figures (1. c.). Taki & Habe (1950) established two new genera, *Neoxylophaga* and *Metaxylophaga*. *Neoxylophaga* is defined in the following way: "General outline of the shell as in *Xylophaga*, but the protoplax is rather small, white, triangular and is covered with the thick brown periostracum". – *N. rikuzenica* described by the two authors in their 1945 paper as a *Xylophaga*, is designated as the type species of *Neoxylophaga*, and in addition, a new species: *N. teramachii* is described. *Metaxylophaga* comprises only one species, *M. supplicata.* No special definition of the genus is given, but from the description of the species, it appears that the authors decided to establish a new genus mainly on the appearance of the mesoplax; this consists of two erect, triangular plates which form an angle in frontal view. TURNER (1956), after having studied the soft parts of *X. washingtona* Bartsch, found that the siphons were similar to those of *atlantica* Richards, described and figured by TURNER (1955). The excurrent siphon is, however, much shorter than in *atlantica* and there are no lappets along the dorsal edge of the incurrent siphon, as is the case in *dorsalis* and *globosa.* From this, TURNER concludes that there are at least two distinct subgenera in the genus *Xylophaga.* The subgenus *Xylophaga* s. str. contains those species with large earshaped dorsal plates and a series of paired lappets along the dorsal edge of the incurrent siphon. This subgenus comprises *X. dorsalis* (Turton), *globosa* Sowerby and *japonica* Taki & Habe. The siphon of the latter species is, however, unknown. The subgenus *Neoxylophaga* Taki & Habe includes species which have small triangular dorsal plates. TURNER (1. c.) suggests that the latter also lack the lappets on the dorsal surface of the incurrent siphon. Besides the type species, *N. rikuzenica,* the following species are referred to the subgenus: *X. washingtona* Bartsch and *atlantica* Richards. TURNER further pointed out that *Metaxylophaga* might be considered a third subgenus, comprising until now, only the type species *M. supplicata* Taki & Habe.

The present material has provided a good opportunity of studying a fairly large and varied collection. It was found that, with the exception of the siphon which exhibited an extraordinary morphological variation from one species to another, the soft parts of the species studied were so much alike that it has not been possible to find specific differences of any importance. A very wide variation was found also in the morphology of the mesoplax while, without doubt, the siphon and the mesoplax, as already pointed out by TAKI & HABE (1. c.) and TURNER (1. c.), yield the best specific characters. However, such characters as the shape of the umbonal reflection, the shape, position and sculpture of the posterior adductor, and the sculpture of the external surface of the shell give good additional characters. In most species a safe identification will only be possible, if at least, the mesoplax is present.

In the present survey it has been possible to study both the mesoplax and siphon in 14 species; results of the observations made should be briefly mentioned before a discussion of the possible bearing on the taxomony of the group is entered upon.

In all the known species of Pholadidae, except *Xylophaga*, the siphon is well developed and both openings are at the tip. In *Xylophaga* the following species have the same type of siphon: *erecta, concava, lobata, hadalis, duplicata* and *X. sp.* Pelseneer.

In the remaining species, however, the excurrent tube undergoes reduction to a varying degree. Some species show a slight reduction in the length of the excurrent tube only and the opening is placed rather close to the incurrent opening: this being the case in *atlantica* (see TURNER 1955, plate 91, fig. 6), *praestans* and *grevei.* A number of species show a further reduction of the excurrent tube, the opening being located at the base of the siphon close to the posterior edge of the shell. The dorsal edge of the siphon shows, however, rudiments of the wall of the excurrent tube. In *turnerae* and *aurita* they appear as low continuous walls, whereas in *dorsalis* (PURCHON 1941) and in *globosa* (TURNER 1955) they are reduced to two rows of lappets. The last stage of the progressive reduction of the excurrent tube is represented by the species having the excurrent opening located close to the posterior edge of the shell and having no remaining rudiments of the wall of the excurrent siphon. In one species, *X. washingtona*, studied by TURNER (1956, no fig.), the siphon is appreciably long, at least two and a half times the length of the shell; in all other species studied: *bruuni, foliata, obtusata, wolfii,* and *africana,* it is considerably reduced in length, and in all the species it was found to be retracted into the shell or to protrude very slightly.

Species having a complete siphon (i. e. a long siphon with both openings at the tip) seem to have very different mesoplax. *X. erecta* and *concava* both have a vertical mesoplax, while in *duplicata, hadalis* and *lobata* the mesoplax is of a completely different type. On the other hand, *aurita,* which has a vertical mesoplax of the same type as *erecta* and *concava* has a reduced excurrent siphon with rudiments of the wall. Of the other species found to have a similar siphon, *turnerae* has a triangular mesoplax with folded basal edges. If all the species having a reduced siphon, with no rudiments of the wall, are compared, it will be seen that they represent widely different types of mesoplax. Thus a simple triangular mesoplax is found in *wolffi, africana* and *bruuni* while the mesoplax of *foliata* is very different. It should finally be mentioned that in *obtusata* the two specimens available show a remarkable variation in the position of the plates of the mesoplax. In one specimen the two plates are horizontal, while in the other the median parts of the plates are raised to form an angle. This last character, as already mentioned, induced TAKI & HABE (1950) to establish a new genus, *Metaxylophaga*.

From the above statements, it might be concluded that a subdivision of *Xylophaga* s. lat., based on the morphology of the siphon and the mesoplax, would be very involved and that the division proposed by TAKI & HABE and TURNER (1956), in view of the evidence gained from the many new species contained in the *Galathea* material, has made the classification much more difficult than previously supposed.

Obviously, the two species *X. dorsalis* and *globosa*. seem to form a distinct unit; being characterized by a large earshaped mesoplax partly covering the umbo and a long siphon with lappets along the dorsal edge. *X. atlantica* and *praestans* appear to form another unit distinguished by a small triangular mesoplax with duplicated basal edges and the excurrent opening located close to the incurrent opening. *X. rikuzenica* Taki & Habe has a similar mesoplax but, unfortunately, the siphon of that species is unknown, making it impossible to state whether it could be grouped with the two species mentioned above. In the present material, *erecta* and *concava* seem to be closely related, both having a vertical mesoplax and a complete siphon. Likewise *obtusata, bruuni* and perhaps *tubulata* appear to be closely linked, owing to the presence of tubes on the mesoplax. The two first mentioned species both have a short siphon, while that of *tubulata* is, unfortunately, unknown. On the whole it would seem that a classification based solely on the structure of the mesoplax and the siphon is at present not possible. To do so would mean the creation of a large number of monotypic genera which would be of limited value only.

Variation

Little is known about the variation in *Xylophaga*. DONS (1929a, 1929b) described variation in the shape of the mesoplax in *praestans* and *dorsalis*. TURNER (1955) reported that specimens of *dorsalis*, boring into coverings of cables, hard wood or other similar substrata are malformed and stenomorphic. The present limited material shows some cases of variation: e. g. the two specimens of *obtusata* – in the shape of the posterior part of the shell, the relative size of the beak and in the shape and position of the mesoplax. Several species show some variation in the shape of the mesoplax: *X. erecta, lobata* and *praestans*. This variation would, to some extent, seem to be related to the size of the specimen. In *grevei* some variation was observed in the sculpture of the shell.

Origin and speciation

At the present stage of knowledge it is not possible to make a safe statement on the origin of *Xylophaga*. TURNER's survey (1954), shows that *Martesia* is known from the Carboniferous and seems to be the most ancient group of the family. The oldest *Xylophaga* come from lower Cretaceous and except for the genus *Barnea*, which appeared at about the same period, the remaining genera are younger, most of them of Tertiary origin. This may support PURCHON's suggestion (1955), that *Xylophaga* branched off at an early stage of the development of the Pholadidae.

It would seem feasible to assume that *Xylophaga* originated in shallow water in the tropics, where abundant plant debris is available from the rivers or in mangrove swamps. However, despite the fact that collecting has been extensive in many tropical areas, not a single species of *Xylophaga* has been found. In these areas, species of the family Teredinidae and the genus *Martesia* (Pholadidae) are the dominating wood borers and it is possible that *Xylophaga* has been eliminated owing to severe competition from the former. DONS (1940) reported an interesting observation which seems to support this view, viz. that in test boards, *Teredo* seems more easily to get a foothold than *Xylophaga*, with the result that a board always contains a greater percentage of *Teredo*. In addition, *Xylophaga* does not start to attack until one month later than *Teredo*. The reason why Teredinidae and *Martesia* are more successful in shallow water than *Xylophaga* is not clear. One possibility is that both these groups produce large numbers of larvae with a pelagic stage of several weeks' duration, while *Xylophaga* produces only a small number of juveniles, without or with a very short pelagic stage.

As far as is known at present, the individual species of *Xylophaga* living in deep water have a rather restricted distribution. This is possibly due to the occurrence of plant debris on the sea bottom probably being patchy and to the juveniles being less efficient in spreading. Both factors would seem to promote speciation within the group.

Carter (1961) stated that the homogeneity of the environment over wide areas of the oceans caused less separation between populations, resulting in a low rate of speciation. This is for instance the case in the Porcellanasteridae (Asteroidea). Madsen (1961) states that in general this family may not be very exacting in their demand on the substratum, this may be one reason accounting for the fact that these animals are, apparently, less apt to speciation than some other deep-sea animals. In *Xylophaga* we may find the opposite, viz. a high degree of speciation owing to the animals being associated with a special type of substratum with a patchy occurrence.

Reproduction

Information in the literature on the reproduction of *Xylophaga* is very scarce. Purchon (1941) discovered *X. dorsalis* (Turton) to be a protandric hermaphrodite; it is provided with vesiculae seminales – a unique structure in bivalves – located posteriorly, in connection with the genital openings. Purchon (1. c.) advocates the possibility of self-fertilization in this species, and suggests that hermaphroditism occurs in other members of the genus. In spite of the fact that there are numerous records of *X. dorsalis* from the East Atlantic the juveniles have never been observed. However, Purchon (1 c.) further suggests that the species incubates its larvae. Lebour (1946) found *dorsalis* containing ripe ova at Plymouth (SW. England) in November, December and March. The ova had a diameter of 0.027 mm. In the present material ova were found in *wolffi* having a diameter of about 0.07 mm. Turner (1954) observed brood protection in the West Atlantic species, *atlantica* Richards. It was found that the young are held within the brood pouch until the late veliger stage. The embryonic shell is about 0.5 mm long with a pronounced concentric sculpture, and metamorphosis of the shell into the adult form begins before the young are released. This would seem to be the only actual observation of brood protection in the genus so far published.

In the present material brood protection has been observed in 9 species. A summary of the observations is found in Table 3. From this it appears that, in most cases, a small number of embryos are found attached to the external side of the shell immediately posterior to the umbo. In a few cases the juveniles are fastened either to the siphon or to the posterior part of the mantle; in some species it could be observed that they are fastened by means of a single byssus thread. The shells were always rounded and in none of the numerous juveniles examined was there any trace of a teleoconch being developed; this is in contrast to the observation made by Turner (1. c.) in *atlantica*, already referred to.

In 3 species, viz. *concava, wolffi* and *tubulata*, material of juveniles in alcohol has been examined. It was ascertained that all the juveniles resembled the adults in their soft parts and no trace of a velum was observed. The size of the juveniles varies slightly from one species to another, but generally, those found within a single female were of a practically uniform size. Only in one species, *Xylophaga tubulata,* was one of the embryos found to be considerably larger than the remainder.

Table 3 shows that the number of juveniles attached to a female is generally small. With one exception, *X. panamensis,* the number is below 10 juveniles per female. This may indicate a very low production of offspring per time unit.

In 5 species of *Xylophaga,* measurements of the maximum length of the prodissoconch could be made which correspond on the whole with the measurements of the juveniles. It will be noticed that in one species, *X. africana,* the embryos found attached to a female are slightly larger than the prodissoconch measured in the two specimens available. This indicates that there is a certain variation in the size of the young at the time they leave the mother animal.

Table 1. Survey of the reproduction of *Xylophaga* from the *Galathea* Expedition.

Species	Location of juveniles	Number of juveniles	Length mm	Length of prodissoconch
concava	mantle	1	0.9	–
lobata	postero-dorsal	1-10	0.3	0.3
panamensis	postero-dorsal	about 50	0.4	–
aurita	–	–	–	0.4
africana	postero-dorsal	9	0.35	0.3
wolffi	postero-dorsal, mantle and siphon	4	2.8-3.1	–
bruuni	postero-dorsal	4	0.35-0.40	–
tubulata	posterior part of the mantle	5	0.6-1.0	–
obtusata	postero-dorsal	2	0.33	–
galatheae	?	1	0.3	0.3
guineensis	–	–	–	0.6

The complete absence of a velum and the size of the juveniles, strongly indicates that the species examined have no real pelagic larval stage.

After the young have left the mother animal they encounter the problem of how to find a suitable piece of plant material. Since they have no velum and, thus, are unable to swim for any considerable distance, it might be assumed that they are either able to crawl on the bottom or that they have a "crawl and swim" stage, during which they may be able to move for short distances. It would seem, however, that the dispersal-efficiency of the *Xylophaga* offspring is very poor. During the present investigations it was repeatedly noted that in hauls containing a large amount of plant debris, which presumably, would be suitable for the uses of *Xylophaga,* only a few pieces, and then not always the largest, were actually bored. This may be due rather to the juveniles' lack of efficiency in spreading than to a high standard of selectivity, since the evidence available, although scanty, seems to show that *Xylophaga* is not very selective in the choice of substratum.

Distribution

Table 2 gives a survey of the present material arranged according to stations. It will be seen that at one station four species of *Xylophaga* were obtained and at another, St. 444, three species were found. The table also shows that, with two exceptions, the individual species occurred only at one station each. Two species, *X. grevei,* and *X. concava,* were found

Table 2. List of species by station.

St, 52, W. Africa, 1°42'N. 7°51'E., 2550 m
africana
guineensis

St. 443, Mindanao Sea, 8°48'N. 124°09'E., 1500 m
grevei
bruuni

St. 444, Sulu Sea, 7°54'N. 121°30'E., 5050 m
erecta
lobata
wolffi

St. 453, Makassar Strait, 3°56'S. 118°26'E., 2000 m
foliata
tubulata

St. 490, Bali Sea, 5°25'S. 117°03'E., 570-545 m
grevei

St. 495, Banda Trench, 5°26'S. 130°58'E., 7290-7250 m
grevei

St. 550, Tasman Sea, 31°27'S. 153°33'E., 4530 m
galatheae

St. 658, Kermadec Trench, 35°51'S. 178°31'W., 6660-6770 m
hadalis

St. 726, Gulf of Panama, 5°49'N. 78°52'W., 3670-3270 m
concava

St. 739, Gulf of Panama, 7°22'N. 79°32'W., 915-975 m
concava
panamensis

St. 745, Gulf of Panama, 7°15'N. 79°25'W., 915 m
duplicata
turnerae
aurita
obtusata

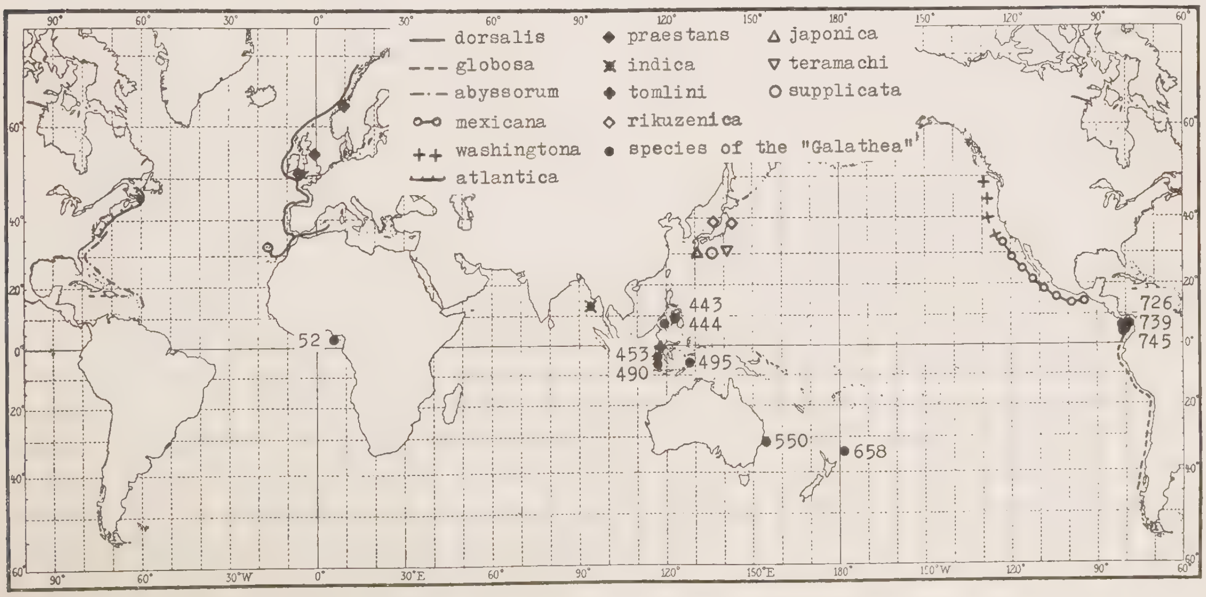

dorsalis
globosa
abyssorum
mexicana
washingtona
atlantica
praestans
indica
tomlini
rikuzenica
species of the "Galathea"
japonica
teramachi
supplicata
52
443
444
453
490
495
550
658
726
739
745
90°
60°
30°W
0°
30°E
60°
90°
120°
150°E
180°
150°W
120°
90°
60°

Fig. 40. The distribution of the known species of *Xylophaga.*

at nearby stations differing widely in depth. A survey of the geographical and bathymetrical distribution of the 30 known species of *Xylophaga* is given in Table 3 and the map (Fig. 40). In the table an attempt has been made to obtain information on the temperatures under which the species live. The evidence available is, however, subject to some doubt. To begin with, several previous authors have not made it clear whether their specimens were alive at time of capture or were, in fact, shells, and in some cases it is not stated whether the material comes from the surface or was actually obtained from the bottom of the sea. Another source of uncertainty arises from the temperature measurements not always being carried out simultaneously with the capture of the specimens. It has been attempted here, however, to give an estimate of the temperature range of each species, or in cases where that has not been possible, to give an indication of the maximum temperature under which a species can occur. In addition, there is still a certain amount of uncertainty in identifying some of the species. Thus, the record of *X. globosa* Sowerby from Panama (DALL 1909), is in need of confirmation, as the species has been reported only from the southern part of the Chilean coast. The records of *X. dorsalis* Turton from depths below 400 meters by DAUTZENBERG (1927), should certainly also be reexamined. They may very well refer to either empty shells or belong to a different species.

The temperatures in Table 3 have been compiled from the following sources: BRUUN 1959, *Investigator* Station List 1914, Japan Meteorological Agency 1959, HARTMAN & BARNARD 1958, SVERDRUP, JOHNSON & FLEMING 1946.

If the division of the sea proposed by BRUUN (1956, 1957) is followed the species of *Xylophaga* may be grouped as follows:

(1) Littoral species, occurring in depths of less than approximately 200-400 m and at temperatures exceeding 11-12° C.: *X. dorsalis. globosa, praestans, washingtona, japonica, supplicata.*

(2) Bathyal species, occurring from about 200-400 m down to about 2000 m and at temperatures between 11-12° C. down to about 4° C.: *X. abyssorum, indica, mexicana, tomlini, rikuzenica, panamensis, duplicata, turnerae, aurita, obtusata.*

(3) Abyssal species, occurring between 2000 and 6000 m at temperatures below 4° C.: *X. foliata, africana, tubulata, galatheae, guineensis.*

(4) Hadal, occurring below 6000 m: *X. hadalis.*

Several species seem to have a wide bathymetrical range, extending from a few hundred to several thousand meters' depth: *abyssorum, atlantica, concava, grevei.* The latter is of special interest since it was found to occur both in bathyal and hadal regions. The three species recorded from the Sulu Sea at 5050 m depth (*X. erecta, lobata* and *wolffi)* fall outside the classification just mentioned since the hydrographical conditions in this basin are remarkable, the temperature being much higher than normal for such depths. It should be pointed out, however, that the above classification is provisional only. Since many species have only been found in one or a few localities a future investigations may alter the situation considerably. Table 3 shows, however, that *Xylophaga* is represented by a considerable number of species in the deep sea and that the majority of known species actually live outside the littoral zone. Another fact seems to have come to light, viz. that the rather few species known from the littoral zone all occur in temperate regions and seem to tolerate maximum temperatures of 15-20° C. In lower latitudes, not a single littoral species occurs, and all species occurring here are confined to the regions below the thermocline. Thus, with our present knowledge, we may safely state that *Xylophaga* is essentially a group confined to the subthermocline regions with a restricted number of species in the littoral zone of the temperate region and able to live at maximum temperatuers up to about 20° C. *Xylophaga,* which, by most authors, is considered a genus within the Pholadidae, seems to be the only genus of the family represented in deep water.

The substratum, boring and feeding of Xylophaga

It has been noticed that plant material seems to be the normal habitat for *Xylophaga,* although DALL (1886) reports that he has actually seen a species which appeared to be *X. abyssorum* Dall, burrowing in a hemp covering said to have been recovered from the North Atlantic at a depth of 1500 fathoms (about 2745 m). TURNER (1955) mentions that *dorsalis* (Turton) has been found in submarine cables. Some species of *Xylophaga* have been reported living in wood floating at the surface, e. g. *dorsalis* and *atlantica* Richards (TURNER l. c.). Occasionally, *X. dorsalis* has been found boring in man-made wooden structures (DONS 1929, TURNER 1955, 1956, NAIR 1959), but as a general rule it does not occur in large numbers and unlike *Teredo,* is not destruc-

Table 3. Survey of the distribution and temperature relation of *Xylophaga*.

Species	Geographical distribution	Bathymetrical distribution	References	Temperature (° C.)
1. *dorsalis*	N. E. Atlantic. From N. Norway (Lofoten) to the Mediterranean	Tidal zone to 2500 m	Dautzenberg 1927 Turner 1955	Max. about 20°
2. *globosa*	S. E. Pacific, from Panama to Chile (Chiloe Isl.)	Tidal zone to 245 m	Turner 1955; Soot-Ryen 1959	Max. about 19°
3. *abyssorum*	W. Atlantic from New Jersey (39°29'N) to the Lesser Antilles (13°51'N)	From 253 to 2456 m (known from shells only)	Turner 1955	4° to about 15° (?)
4. *praestans*	N. E. Atlantic	30-82 m	E. A. Smith 1903; Dons 1929; Purchon 1941	From about 4° to about 18°
5. *indica*	Indian Ocean	339 m	E. A. Smith 1904	11.9°
6. *mexicana*	E. Pacific, from California (33°36'N) to Mexico (16°47'N)	258 to 805 m	Turner 1955; Hartmann & Barnard 1958, 1960	about 5°
7. *washingtona*	N. E. Pacific, Washington (48°31'N) to California (33°31'N)	18-249 m	Turner 1955, 1956	10°-15°
8. *tomlini*	Indo-Malayan Sea	1301 m	Prashad 1932	about 4°
9. *atlantica*	N. W. Atlantic, from St. Lawrence Estuary (48° N) to Cape Henry, Virginia (36° N)	Littoral to 3175 m	Turner 1955	Max. about 23°
10. *rikuzenica*	N. W. Pacific, Honchu Japan	183-1281 m	Taki & Habe 1945, 1950	Max. about 6°
11. *japonica*	N. W. Pacific, Shikoku, Japan	183 m	Taki & Habe 1950	Max. 11°-12°
12. *teramachi*	N. W. Pacific, Shikoku, Japan	?	Taki & habe 1950	?
13. *supplicata*	N. W. Pacific, Shikoku,	183 m	Taki & habe 1950	Max. 11°-12°
14. *erecta*	Sulu Sea	5050 m	present paper	10.6°
15. *concava*	Gulf of Panama	915-3670 m	- -	2°-5°
16. *lobata*	Sulu Sea	5050 m	- -	10.6°
17. *panamensis*	Gulf of Panama	915-975 m	- -	about 5°
18. *hadalis*	Kermadec Trench	6660-6770 m	- -	1.3°
19. *duplicata*	Gulf of Panama	915 m	- -	about 5°
20. *foliata*	Macassar Strait	2000 m	- -	3.6°
21. *grevei*	Indo-Malayan Sea	545-7290 m	- -	3.6° to about 7.4°
22. *turnerae*	Gulf of Panama	915 m	- -	about 5°
23. *aurita*	Gulf of Panama	915 m	- -	about 5°
24. *africana*	W. Coast of Africa	2550 m	- -	about 3°
25. *wolffi*	Sulu Sea	5050 m	- -	10.6°
26. *bruuni*	Mindanao Sea	1500 m	- -	about 10°
27. *tubulata*	Macassar Strait	2000 m	- -	3.6°
28. *obtusata*	Gulf of Panama	915 m	- -	about 5°
29. *galatheae*	Tasman Sea	4530 m	- -	about 1°
30. *guineensis*	W. Coast of Africa	2550 m	- -	about 3°

tive. It is usually found in waterlogged remnants of plants which, particularly in the tropics, occur quite frequently, even in very deep water (see p. 205). It should be mentioned here that *abyssorum*, according to TURNER (1955), has never been known to bore in wood. However, the species is known from empty shells only; therefore, although the possibility that it actually might live on the sea bottom cannot be completely ruled out, it seems likely that this species also has its normal habitat in plant material. In the *Galathea* material no plant material was recorded from St. 453, from which two species of *Xylophaga* were obtained alive. No doubt plant remnants must have occurred at this station also.

During the present investigation it was observed that *Xylophaga* are not confined to larger pieces of wood. Quite often they can also be found in large numbers in quite small twigs, as e. g. *galatheae* and *lobata*. Wood, as well as other kinds of plant material, may be used. The specimen of *grevei* from St. 495 was removed from a *Pandanus* fruit, some of the specimens of *lobata* from a piece of bamboo, and *africana* was obtained from a piece of coconut shell. At least some species of *Xylophaga* attack various kinds of plant material. DONS (1940) found *dorsalis* in test boards of both spruce and fir, although it seemed to prefer the latter. Wood of deciduous trees was found to be the favorite substratum, particularly branches with the bark preserved. DONS suggests that this may be due to the fact that it is more difficult for the juveniles to get a foothold in wood without bark. In one test board it could be observed that 211 juvenile *Xylophaga* had attempted to settle, but only 13 had succeeded in getting a permanent foothold. The succesful assault of *lobata* in a piece of bamboo, observed in the present material, shows however, that it is possible for juveniles to start boring even if there is no soft bark. It is not known how the juveniles begin to attack. In the present material the young were never seen to commence their boring from the burrows of the mother; apparently boring is always begun from the exterior. DONS (1940) observed that the juveniles produce circular, cup shaped depressions, which are similar to those of *Teredo,* but much larger. This was observed also in the present material. At St. 444 pieces of branches were found with numerous juveniles of *lobata* in situ; they still had the rounded prodissoconch, without any trace of the teleoconch. Unfortunately, it could not be observed whether the juveniles fasten themselves to the substratum by means of a byssus, in the same way as they are fastened to the mother. WERNER (1939) observed that during the boring of *Zirfaea crispata* L. (Pholadidae) the juveniles had developed small denticles inside the ventral edge of the shell, and suggests that these might serve either as a means to secure the juveniles to the substratum, or as a tool to commence boring. However, an examination of a number of juveniles found in the present material failed to demonstrate similar denticles in *Xylophaga.*

Very little is known about the rate of growth in *Xylophaga* although the scanty information available seems to indicate that it is relatively fast. DONS (1940) found that the holes bored by *dorsalis* attained a maximum length of nearly 50 mm within a year. TURNER (1956) observed that specimens of *washingtona* Bartsch reached a maximum length of about 4 mm between September 12, 1955 and January 7, 1956.

The borings of *Xylophaga* are oblong-pearshaped and in contrast to those of *Teredo,* the internal wall is not covered with a calcareous layer. Another obvious difference between the borings of the two genera is that the holes of *Teredo* follow the grain of the wood while the holes of *Xylophaga* are often at right angles to the grain. The posterior part of the borings are almost completely occupied by a tube consisting of particles produced by the boring. The tube is often referred to as the "chimney" and adheres to the posterior part of the shell. During the present investigation it has been noticed on several occasions that a specimen may bore into the hole of its neighbour (Fig. 41) and even cut away part of the chimney. At no time was it observed that a specimen had damaged the shell or soft parts of its neighbour.

DONS (1940) and LEBOUR (1946) report that *Xylophaga dorsalis* may occur together with *Teredo.* During the present investigation *Teredo*, sp. were observed to occur together with *X. bilobata* at St. 444, and *grevei* at St. 495. It is not known whether the *Teredo* sp. belong to endemic deep sea species or whether they began their attack while the plant debris was still floating at the surface, and were able to survive even after the plant material had been deposited at the sea bottom.

Some evidence has been found which seems to indicate that a single piece of wood may be subjected to several consecutive attacks of *Xylophaga.* This was observed in a twig from St. 444 inhabited by *lobata;* the interior was inhabited by numerous adult specimens, while the peripherical parts har-

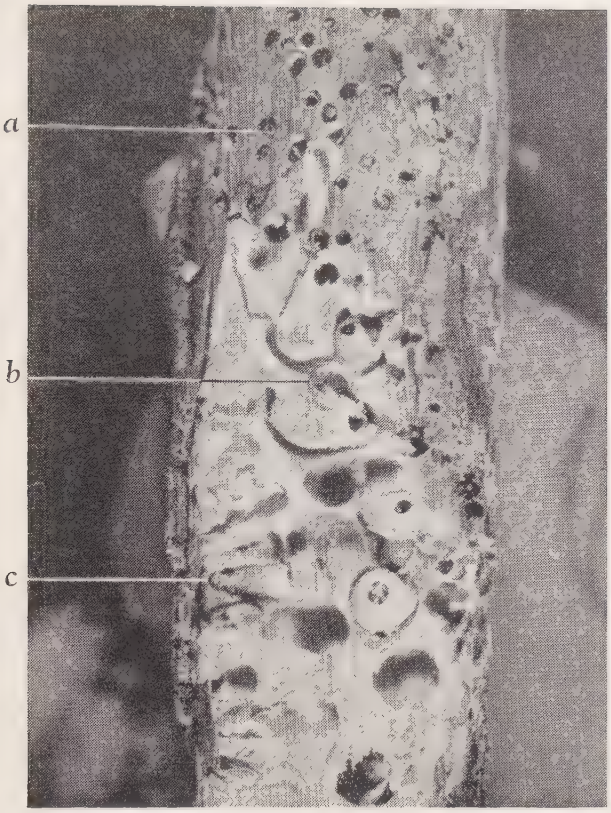


Fig. 41. Small twig densely inhabited by *Xylophaga galatheae* n. sp. Above the numerous external openings of the cavities can be seen. In some of the openings the upper edge of a chimney is visible (a). At (b) a *Xylophaga* has dug into the chimney of its neighbor and the cavities of at least three individuals have been united. At (c) a lateral view of a chimney.

boured a dense population of juveniles, obviously recently settled.

If, through the continued growth of *Xylophaga*, a twig should split or break into pieces, this will prove catastrophic to the *Xylophaga;* they will thereby be deprived of their protection and are not able to find another piece of wood and start another boring.

Turner (1955) gave a review of the methods of boring in the Pholadidae. Several earlier authors have suggested that boring was accomplished by means of an acid. This does not seem to be the case and it is now generally assumed that the boring is purely a mechanical process, carried out by the shell by means of movements of the anterior adductor and assisted by several other organs such as the foot, siphon and mantle. The exact methods of boring seem to vary from one species to another and within one species it may vary in accordance with the hardness of the substratum. Nothing seems to be known about the boring mechanism in *Xylophaga*. It should be noted that Purchon (1955) suggested that the rôle of the mesoplax might be to protect the anterior adductor. However, no protection is rendered by a vertical mesoplax, which has been found in several species of the *Galathea* material, or by one occupying only part of the anterior incision. The fact that, at least in some species, part of the anterior adductor is fixed to the ventral surface of the mesoplax, may indicate that the mesoplax plays a rôle in the movements of the shell during boring. The curious "joints" observed in the mesoplax of *X. foliata* strongly suggest that regular movements do take place.

The question of what *Xylophaga* feeds on is still subject to some controversy. Yonge (1937) concluded that *Xylophaga* was unable to digest wood, whereas Purchon (1941), alternatively stated that it is, at least to some extent, able to digest wood but may be independent of it since specimens of *Xylophaga* have been found in the gutta-percha sheaths of submarine telegraph cables. He suggests that such specimens must subsist entirely upon plankton or suspended matter in the water. Purchon found indication of the presence of cellulase in *X. dorsalis*, and concludes that it is not impossible that the bacteria found in the coecum may feed on the wood and then be ingested by the phagocytes.

An examination of the fecal pellets of several species of *Xylophaga* from the present collection showed that they consisted of, what appeared to be, fine particles of wood and no trace of other items such as plankton or suspended matter could be detected. It is possible that the suggestion made by Purchon given above is correct and that plant material is the only source of food and made available through the action of bacteria. The specimens found in cables might, in actual fact, have lived in the plant fibres used for isolating the cables and not in the outer gutta-percha sheaths, surrounding the plant fibres.

Terrestrial plant debris in the deep sea

Several expeditions have reported the occurrence of remnants of terrestrial plants in deep water. The *Challenger* Expedition found plant debris at 9 different stations between 800 and 2150 fathoms (1464-3935 m), mostly in the waters round the Phillipines and New Guinea (Murray 1895). It has been remarked that some of the hauls from these stations were extraordinarily rich, both in specimens and species. Similarly, the *Blake* Expedition, while working in the West Indian waters, found pieces of bamboo, sugar cane, leaves, etc. at a depth of over 2000 m, and it was noted here that the presence of plant material causes an abundance of specimens. The *Siboga* Expedition (WEBER 1902), found an abundance of plant debris at several stations in the Indonesian waters, one of them at a depth of 2053 m. MORTENSEN (1938) found plant material in plenty during his expedition to the Indonesian waters, at depths between 200 and 300 m, and he too, noticed the abundance of animal life at these stations. On examining the stomach content of some species of sea urchins, he found it to consist of pieces of terrestrial plants and concluded that these species survive on a vegetarian diet. The question was discussed by BRUUN (1957), who held the opinion that although it cannot be completely ruled out that the plant debris itself may serve as food for many deep sea organisms, it would seem more likely that as they are probably unable to directly utilize the cellulose, the animals exist rather on the bacterian (and protozoan) life living on the plants.

The *Galathea* Expedition found plant remnants from no less than 56 different stations (BRUUN 1959), on some occasions in quite large quantities; e. g. a huge trunk was retrieved in the Gulf of Panama from a depth of 915 m and on five occasions more than 1000 ccm of plant material was brought up from depths between 545 and 5050 m. In addition, small quantities were obtained in the Philippine Trench, the Banda Trench, the New Britain Trench and the Kermadec Trench, at depths exceeding 6000 m.

From the records of the expeditions mentioned, it appears that plant debris is found in many places in the deep sea, particularly in tropical regions such as the Indonesian waters, the Gulf of Bengal and the Panama Gulf. On the other hand, in the temperate regions of the deep-sea, plant debris seems to be rarely met with, although there are some records from here too; the *Porcupine* Expedition found plant material at a depth of about 944 m off the British Isles and the *Ingolf* Expedition brought up a large piece of wood southwest of Iceland at a depth of about 1833 m (JENSEN 1912).

An examination of the results of some previous expeditions would seem to indicate that not only is plant debris an important link in the food chain of deep-sea animals but it is also used by a number of organisms as a habitat. AGASSIZ (1888) records *Xylopagurus,* a bilaterial hermit crab, living in hollow pieces of bamboo from depths of 183-366 meters in the West Indian waters. The *Galathea* collected another *Xylopagurus* at St. 443 in the Mindanao Sea at a depth of 1500 m (T. WOLFF, personal communication). BALSS (1912), in his report of the Paguridea of the *Valdivia* Expedition, mentions three species of symmetrical pagurids living in pieces of bamboo. WEBER (1902) found that plant debris from deep water always contained a small fauna of its own (*Teredo* and a number of other bivalves, white ophiuroids, chitons, annelids, actinarians and isopods), but unfortunately this question was never dealt with in detail. JENSEN (1912), in his report of bivalves from the *Ingolf* Expedition, mentions a species, *Idasola argentea,* belonging to the family Mytilidae, it was first taken alive by the *Triton* Expedition between the Hebrides and the Faroes, at a depth of 944 m. The animals were living in vacant tubes of *Teredo* in a piece of a tree trunk dredged from the bottom. In the material of the *Ingolf* Expedition numerous specimens of *Idasola argentea* were found also living in *Teredo* tubes, in a tree trunk dredged to the south west of Iceland, at a depth of 1833 m. It is suggested by JENSEN that this is the normal habitat of the species, and that the few records outside this habitat all refer to shells only. THIELE & JAECKEL (1932), in their report of the bivalves of the *Valdivia* Expedition described another species of Mytilidae – *Myrina longissima* – from the Indian Ocean at a depth of 1143 m; it is stated that the species was found fixed by means of its byssus to the fibres of a coco-nut-like fruit with the pointed (i. e. anterior) end inwards. In this connection it is of interest to note that E. A. SMITH (1885) described a new species, *Myrina coppingeri,* from the Pacific, 2560 m, at one of the stations rich in plant debris. Although it is not mentioned, the possibility exists that it used the plant debris as a substratum.

Besides the species of *Xylophaga* dealt with in the present paper, the collections of the *Galathea* Expedition give some evidence on the possible existence of a specific fauna, associated with material of terrestrial plant debris, deposited on the bottom of the deep sea. Among the bivalves, it is of considerable interest to note that the expedition found *Myrina longissima* Jaeckel & Thiele at St. 443, east of the Philippines, at a depth of 1500 m. This is the second record of the species and it was, also on this occasion, found fixed to the fibres of a coco nut. These two records might thus indicate that this is the normal habitat of the species. Another species of Mytilidae – possibly a new species of the genus *Idasola* – was taken in the Gulf of Panama at a depth of 3270-

3670 m, picked out from a tree trunk; it is possible that it lives in the same manner as *I. argentea* from the North Atlantic.

Among the other groups of intervertebrates, the following examples should be mentioned: KIRKEGAARD (1956) described the polychaete *Nereis profundi* from the Banda Trench, *Galathea* St. 495, the species was found living in a *Pandanus* fruit, which also contained *Xylophaga grevei* and some small specimens of a unidentified species of *Teredo,* and is stated to live in the tubes of the latter.

BARNARD (1961) mentions three species of amphipoda which live in wood: *Onesimoides chelatus* Pirlot, *Bathyceradocus stephenseni* Pirlot and *Melita lignophila* Barnard. The stomach content of the two first-mentioned species was found to consist of wood particles. WOLFF (in press) records a *Janira* n. sp. (Isopoda), which was collected from a tree trunk at *Galathea* St. 726. The log book of the *Galathea* further states that, at the same station, specimens of a "*Munidopsis*" sp. were collected from the same tree-trunk.

Although there is, up to the present, no evidence that one or several animal communities in the deep sea are associated with remnants of terrestrial plants, there are probably several species whose normal habitat is either in them, or attached to them. It seems likely that the boring species, such as *Xylophaga,* will to a considerable degree, accelerate the mechanical breaking down of the plant material and thereby faciliate the activity of the wood-digesting bacterians.

F. SUMMARY

1. A review of the known species of *Xylophaga* shows that up to the present time 13 species are known.

2. The *Galathea* Expedition collected 17 different species of *Xylophaga,* which all appeared to be new species. These are described and figured, and in addition, descriptions and figures are given of 4 previously known species.

3. Earlier attempts to subdivide *Xylophaga,* based on the morphology of the mesoplax and the siphon are summarized. It is concluded that in view of the great variation found in these characters during the present investigation this subdivision cannot be upheld. It is suggested that a subdivision is at present not possible.

4. In a few species some variation in the shape of the shell and the mesoplax could be observed.

5. It is proposed that *Xylophaga* originated in shallow water in the tropics but has here been replaced by more succuessful groups such as *Teredo* and *Martesia.* This may be due to the low productive rate and low dispersal efficiency of *Xylophaga* compared to the two other groups.

6. Owing to the patchy occurrence of plant debris and the poor dispersal efficiency, the populations of *Xylophaga* must be subjected to a high degree of isolation bringing, about speciation, which explains the astonishingly large number of species occurring in deep water.

7. Brood protection has been observed in 9 species of the present material. The young are either at the postero-dorsal part of the shell or at the siphon. The number of juveniles is from 1-10, only one species had about 50 juveniles attached. The juveniles measure 0.3-1.0 mm in length, indicating that no pelagic stage is present.

8. The distribution of all known species of *Xylophaga* is shown on the map (Fig. 40). Table 2 shows the *Galathea* material arranged according to stations. Species found in deep water seem mostly to have very restricted areas of distribution. The bathymetrical distribution and the temperature relations of *Xylophaga* are given in Table 3. It appears that the genus is essentially a deep-sea group. Six species appear to be littoral, 10 are bathyal, 5 are abyssal and 1 hadal. Four species have a wide bathymetrical distribution ranging from a few hundred to several thousand meters. Of these, one species was found both in the bathyal and the hadal region. In addition, 3 species were found in the Sulu basin. The littoral species all appear to live in temperate regions and so far, no *Xylophaga* has been found in the littoral waters of the tropics.

9. Previous observations on the boring of *Xylophaga* are summarized and new observations added. Several species of *Xylophaga* have been found boring

in different kinds of plant material, and in several cases *Xylophaga* was found together with *Teredo* sp.

10. The problem of the food eaten by *Xylophaga* has not been finally solved. The fecal pellets of the present collection seemed to consist entirely of particles originating from the plant material bored. Possibly, bacteria digest the plant material and are, in turn devoured by *Xylophaga*.

11. A review is given of the occurrence of plant debris in the deep-sea. There seem to be a number of species associated with plant debris, either for shelter or for feeding purposes.

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